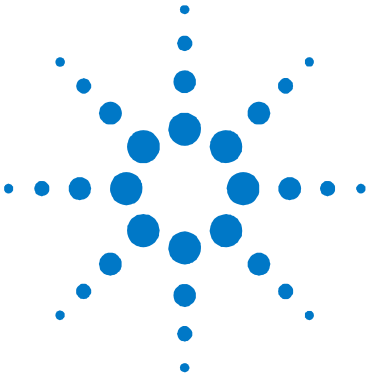

Agilent Technologies Low-Profile Modular Power System

Series N6700

Service Guide

Agilent Technologies

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The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or instructions elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

General

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the unit before applying power. Note the instrument's external markings described under "Safety Symbols"

Ground the Instrument

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Fuses

The instrument contains an internal fuse, which is not customer accessible.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Agilent Sales and Service Office for service and repair to ensure that safety features are maintained.

In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Safety Symbols

Direct current

Alternating current

Both direct and alternating current

Three phase alternating current

Earth (ground) terminal

Protective earth ground terminal.

Frame or chassis terminal

Terminal is at earth potential.

Neutral conductor on permanently installed equipment

Line conductor on permanently installed equipment.

On supply

Off supply

Standby supply. Unit is not completely disconnected from ac mains when switch is off

In position of a bi-stable push switch

Out position of a bi-stable push switch

Caution, risk of electric shock

Caution, hot surface

Caution, refer to accompanying description

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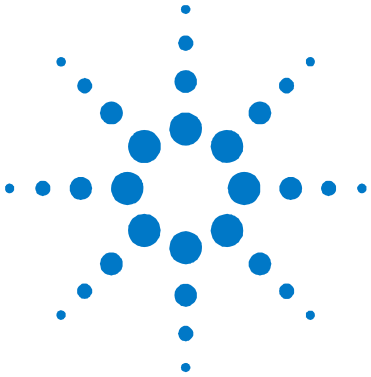

1 Introduction

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This manual discusses the troubleshooting procedures for the N6700B, N6701A, and N6702A MPS mainframes. Troubleshooting procedures are provided to isolate defective assemblies. These procedures do not troubleshoot to the component level.

No procedures are provided for troubleshooting individual modules - other than identifying if a specific module is defective. If you have a defective module, you can return it to Agilent Technologies for repair or replacement. Refer to the following note.

NOTE

You can contact Agilent Technologies at one of the following telephone numbers for warranty, service, or technical support information.
In the United States: (800) 829-4444
In Europe: 31 20 547 2111
In Japan: 0120-421-345
Or use our Web link for information on contacting Agilent in your country or specific location: www.agilent.com/find/assist
Or contact your Agilent Technologies Representative.

The web contains the most up to date version of the manuals. Go to http://www.agilent.com/find/N6700 to get the latest version of the manuals.

Returning an Instrument

Before returning your instrument to Agilent Technologies for service or repair, perform the “Preliminary Checkout” procedures in the beginning of chapter 4.

Warranty Repair

If your instrument fails during the warranty period, Agilent Technologies will replace or repair it free of charge. After your warranty expires, Agilent Technologies will replace or repair it at a competitive price. The standard repair process is “whole unit exchange”. The replacement units are fully refurbished and are shipped with new calibration certificates.

Contact your nearest Agilent Technologies Service Center. They will arrange to have your instrument repaired or replaced.

Repackaging for Shipment

If the unit is to be shipped to Agilent Technologies for service or repair, be sure to:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model and serial number.
- Place the unit in its original container with the appropriate packaging material and secure the container with strong tape or metal bands.

If the original shipping container is not available, place your unit in a container that will ensure at least 4 inches of compressible packaging material around all sides for the instrument. Use static-free packaging materials to avoid additional damage to your unit.

Agilent Technologies suggests that you always insure shipments.

Instrument Identification

Serial Number

Agilent N6700 MPS mainframes are identified by the serial number located on the interface cover.

The serial number consists of a 10-character number (e.g. MY24D00013) located on the label on the top of the interface board. The first two characters indicate the country of manufacture, and the last five digits are a sequential number assigned to each mainframe.

Additional Information

For Agilent N6700 MPS mainframes, you can query the model number, serial number, firmware revision, backup and active firmware.

For power modules, you can query the model number, serial number, installed options, voltage, current and power rating.

Front Panel:	SCPI Command:

Select **System\About\Frame**.
or
Select **System\About\Module**.
	For mainframe information:
	`*IDN?`
	For information about the power module in channel 1:
	`SYST:CHAN:MOD? (@1)`
	`SYST:CHAN:OPT? (@1)`
	`SYST:CHAN:SER? (@1)`

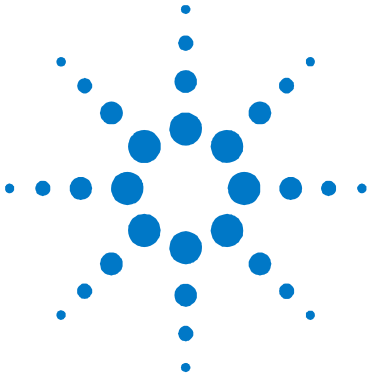
Firmware Upgrade

You can query the instrument's firmware revision either from the front panel or over the remote interface as previously described under "Additional Information".

To upgrade your instrument with the latest firmware revision, go to http://www.agilent.com/find/N6700firmware. The upgrade procedure consists of the following three steps:

- Download and install the Agilent N6700 Firmware Update Utility from the Web.
- Download and unzip the Agilent N6700 Firmware Update file from the Web.
- Run the Agilent N6700 Firmware Update Utility and update the firmware on your instrument.

NOTE Refer to Appendix B for information about firmware revisions prior to D.01.07.



2
Performance Verification

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The verification procedures described in this chapter verify that the Agilent N6700 Modular Power System is operating normally and is within published specifications.

NOTE Perform the verification tests before calibrating your power system. If the power system passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.

Verification procedures perform two primary functions:

Performance Tests These tests verify that the power system is operating normally and meets the specifications published in the Agilent N6700 Modular Power System Family Specifications Guide.

Calibration Tests These tests verify that the power system is operating within its calibration limits.

If the instrument fails any of the tests or if abnormal test results are obtained, try calibrating the unit. If calibration is unsuccessful, return the unit to an Agilent Technologies Service Center.

Verification Description

Verification and Calibration Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for the performance tests and for calibration. Test record sheets are included at the back of this section.

Type	Specifications	Recommended Model
Digital Multimeter	Resolution: 10 nV @ 1V; Readout: 8 1/2 digits Accuracy: 20 ppm	Agilent 3458A or equivalent
Current Monitor	15 A (0.1 ohm), TC = 4ppm/°C 30 A (0.1 ohm), TC = 4ppm/°C 50 A (0.05 ohm), TC = 4ppm/°C	Guildline 9230A-15R Guildline 9230A-30 Guildline 9230A-50
Load Resistors	25 Ω, 250 W, 1% (calibration, N6751A/52A; N6761A/62A) 4 Ω, 250 W, 1% (calibration, N6751A/52A; N6761A/62A) 20 kΩ, 1%, 1/8W (verification, calibration for 1UA/2UA) 10 Ω, 1%, 1/8W (verification, calibration for N678xA SMU) 10 kΩ, 1%, 1/8W (verification, calibration for N678xA SMU) 1 MΩ, 1%, 1/8W (verification, calibration for N678xA SMU)	Vishay NH-250-25Ω-1% Vishay NH-250-4Ω-1%
Electronic Load	150 V, 50 A minimum, with transient capability and a slew rate of 833 kA/s or better.	Agilent N3300A mainframe, with N330xA modules
Agilent N6784A	Load for N678xA SMU and N6783A (set to CC load mode)	Agilent N6784A
GPIB Controller	Full GPIB capabilities	Agilent 82350B or equivalent
Oscilloscope	Sensitivity: 1 mV; Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip	Agilent Infiniium/6054A or equivalent
RMS Voltmeter	True RMS; Bandwidth: 20 MHz Sensitivity: 100 μV	Rhode and Schwartz Model URE3 or equivalent
Differential Amp.	Bandwidth: 20 MHz	LeCroy 1855A or equivalent
Terminations	1 – 50 Ω BNC termination 2 – 50 Ω, 1/8 W termination resistors	
Variable voltage transformer or AC source	Adjustable to highest rated input voltage range. Power: 500 VA	Agilent 6813B or equivalent
RC – for N678xA transient test	Capacitor: 150 μF fixed film Resistor 50 mΩ	EPCOS B32526R0157K Vishay LVR01R0500FE70

Measurement Techniques

Voltmeter

To ensure that the values read by the voltmeter during both the verification procedure and the calibration procedure are not affected by the instantaneous measurement of the AC peaks of the output current ripple, make several DC measurements and average them.

If you are using an Agilent 3458A DMM, you can set up the voltmeter to do this automatically. From the instrument's front panel, program 100 power line cycles per measurement. Press NPLC 100 ENTER.

If you are using an Agilent 3458A DMM, turn on auto-calibration (ACAL) and the autorange function (ARANGE). For best results, auto-calibration should be performed every 24 hours when verifying or calibrating models N678xA SMU.

Current-Monitoring Resistor

The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

Electronic Load

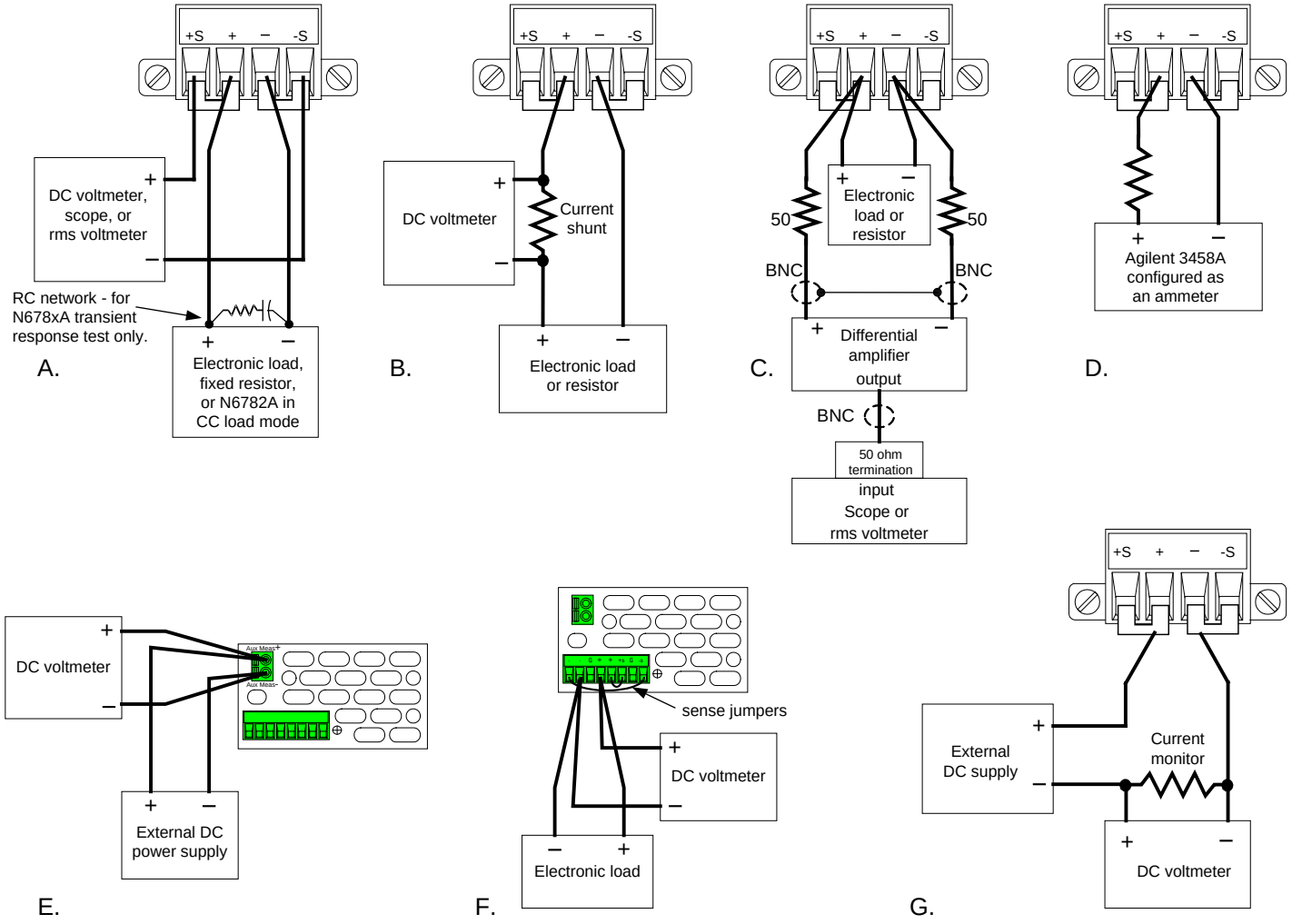
Many of the test procedures require the use of a variable load capable of dissipating the required power. If a variable resistor is used, switches should be used to connect, disconnect, or short the load resistor. For most tests, an electronic load can be used. The electronic load is considerably easier to use than load resistors, but it may not be fast enough to test transient recovery time and may be too noisy for the noise (PARD) tests.

Fixed load resistors may be used in place of a variable load, with minor changes to the test procedures. Also, if computer controlled test setups are used, the relatively slow (compared to computers and system voltmeters) settling times and slew rates of the power system may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the power system.

Unless stated otherwise, an N6784A power module should be used as the load when testing models N678xA SMU, and transient response for models N6783A.

Verification Test Set-up

The following figures show the verification test set-ups. Connect all leads to the output terminals as shown in the following figure. Twist the + and - load leads to reduce noise and inductance.



NOTE Load lead lengths for models N678xA SMU must be between 1 and 4 feet.

Verification Procedure

Constant Voltage Tests

NOTE Test each output channel individually. Refer to the appropriate test record form for the instrument settings of the model you are checking.

Voltage Programming and Readback Accuracy

Test category = performance, calibration

This test verifies that the voltage programming and measurement functions are within specifications.

1. Turn off the power system and connect a DMM across the sense terminals (see Test Setup A). Do not connect the load.
2. Turn on the power system and program the instrument settings as described in the test record form under “Voltage Programming & Readback, Min Voltage”. Turn the output on. The output status should be “CV” and the output current should be close to zero.
3. Record the output voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, Minimum Voltage”.
4. Program the instrument settings as described in the test record form under “Voltage Programming & Readback, High Voltage”.
5. Record the output voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, High Voltage”.
6. *For models N6761A, N6762A, and N678xA SMU only.* Set both the voltage programming and the voltage measurement to the low range (5.5 V for models N6761A and N6762A; 6 V programming and 1 V measurement for models N678xA SMU). Set the instrument as described under “Voltage Programming & Readback, Low Voltage”. Repeat step 5 for the low voltage range. The readings should be within the limits specified under “Voltage Programming & Readback Low Voltage”.
7. *For models N678xA SMU only.* Set the voltage programming to the 600 mV range and the voltage measurement to the 100 mV range. Set the instrument as described under “600 mV Programming & 100 mV Readback”. Repeat step 5. The readings should be within the limits specified under “600 mV Programming & 100 mV Readback”.
8. *For models N6763A – N6766A only.* Set the instrument as described under “Voltage Readback, Low Voltage”. Record the voltage measured over the interface. The reading should be within the limits specified under “Voltage Readback Low Range”.

Test category = performance

This test measures the change in output voltage resulting from a change in output current from full load to no load.

1. Turn off the power system and connect a DMM and an electronic load (see Test Setup A).
2. Turn on the power system and program the instrument settings as described in the test record form under “CV Load Effect”.
3. Set the electronic load for the output channel’s current as described in the test record form under “CV Load Effect”. The output status should be “CV”. If it isn’t, adjust the load so that the output current drops slightly.
4. Record the output voltage reading from the DMM.
5. Open the load. Record the voltage reading from the DMM again. The difference between the DMM readings in steps 4 and 5 is the load effect, which should not exceed the value listed in the test record form for the appropriate model under “CV Load Effect”.
6. *For models N678xA SMU only.* Repeat steps 2 through 5 for the 6 V range.

CV Source Effect

Test category = performance

This test measures the change in output voltage that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

1. Turn off the power system and connect the ac power line through a variable voltage transformer or an AC source.
2. Connect a DMM and an electronic load (see Test Setup A). Set the transformer or AC source to nominal line voltage.
3. Turn on the power system and program the instrument settings as described in the test record form under “CV Source Effect”.
4. Set the electronic load for the output channel’s current as described in the test record form under “CV Source Effect”. The output status should be “CV”. If it isn’t, adjust the load so that the output current drops slightly.
5. Adjust the AC input to the lowest rated line voltage (86 VAC).
6. Record the output voltage reading from the DMM.
7. Adjust the AC input to the highest rated line voltage (264 VAC).
8. Record the output voltage reading on the DMM. The difference between the DMM reading in steps 6 and 8 is the source effect, which should not exceed the value listed in the test record form for the appropriate model under “CV Source Effect”.

CV Ripple and Noise

Test category = performance

Periodic and random deviations in the output combine to produce a residual AC voltage superimposed on the DC output voltage. This residual voltage is specified as the rms or peak-to-peak noise in the frequency range specified in the Agilent N6700 Modular Power System Family Specifications Guide.

1. Turn off the power system and connect a load resistor or electronic load, differential amplifier, and an oscilloscope (ac coupled) to the output (see Test Setup C)..
2. *For models N6751A/52A, N6761A/62A, and N678xA SMU* - use an appropriate load resistor to keep the power system at the instrument setting specified in the test record form under “CV Ripple and Noise”. For all other power modules - use an electronic load to keep the power system at the instrument setting specified in the test record form under “CV Ripple and Noise”.
3. As shown in the diagram, use two BNC cables to connect the differential amplifier to the + and – output terminals. Each cable should be terminated by a 50 Ω resistor. The shields of the two BNC cables should be connected together. Connect the output of the differential amplifier to the oscilloscope with a 50 Ω termination at the input of the oscilloscope.
4. Set the differential amplifier to multiply by ten, divide by one, and 1 MΩ input resistance. The positive and negative inputs of the differential amplifier should be set to AC coupling. Set the oscilloscope’s time base to 5 ms/div, and the vertical scale to 10 mV/div. Turn the bandwidth limit on (usually 20 or 30 MHz), and set the sampling mode to peak detect.
5. Program the power system to the settings indicated in the in the test record form for the appropriate model under “CV Ripple and Noise” and enable the output. Let the oscilloscope run for a few seconds to generate enough measurement points. On the Agilent Infiniium scope, the maximum peak-to-peak voltage measurement is indicated at the bottom of the screen on the right side. Divide this value by 10 to get the CV peak-to-peak noise measurement. The result should not exceed the peak-to-peak limits in the test record form for the appropriate model under “CV Ripple and Noise, peak-to-peak”.

NOTE If the measurement contains any question marks, clear the measurement and try again. This means that some of the scope data received was questionable.

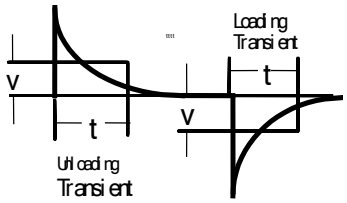
6. Disconnect the oscilloscope and connect an rms voltmeter in its place. Do not disconnect the 50 ohm termination. Divide the reading of the rms voltmeter by 10. The result should not exceed the rms limits in the test record form for the appropriate model under “CV Ripple and Noise, rms”.
7. *For models N678xA SMU only.* Repeat steps 2 through 6 for the 6 V range.

Transient Recovery Time (all except N678xA SMU and N6783A)

Test category = performance

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load current.

1. Turn off the power system and connect an oscilloscope across the sense terminals (see Test Setup A). Connect an electronic load to the output terminals.
2. Turn on the power system and program the instrument settings as described in the test record form under “Transient Response”.
3. Set the electronic load to operate in constant current mode. Program its load current to the lower current value indicated in the test record form under “Transient Response”.
4. Set the electronic load's transient generator frequency to 100 Hz and its duty cycle to 50%.
5. Program the load's transient current level to the higher current value indicated in the test record form under “Transient Response”, and turn the transient generator on.
6. Adjust the oscilloscope for a waveform similar to that shown in the following figure.



7. The output voltage should return to within the specified voltage at the specified time following the 50% load change. Check both loading and unloading transients by triggering on the positive and negative slope. Record the voltage at time “t” in the performance test record form under “Transient Response”.

Transient Recovery Time (N678xA SMU and N6783A only)

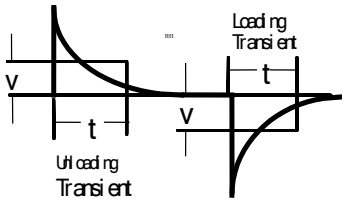
Test category = performance

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load currents of the 6 V range and the 20 V range for models N678xA SMU.

1. Turn off the power system and connect an oscilloscope across the sense terminals (see Test Setup A). Connect an N6784A as a load to the output terminals. For models N678xA SMU only, observe the following additional connection requirements:
   a. Twist the load leads, length must be between 1 and 4 ft.
   b. Connect a 150 µF capacitor and 50 mΩ resistor directly across the load.
2. Turn on the power system and program the instrument settings as shown in the test record form under “Transient Response 6V”.

3 Set the N6784A that is being used as the load as follows:
   a. Emulation Mode = CC Load (in current priority mode)
   b. + Voltage limit = 6.12 V
   c. Current Slew setting:
      N678xA: Maximum (the default)
      N6783A: 67500 A/s (for a pulse rise/fall time of 20 μs)
   d. Arb = Current Pulse
   e. Load pulse properties:
      N678xA: I_0= −0.1 A; I_1= −1.5A; T_0= 1ms; T_1= 1ms; T_2= 1ms
      N6783A: I_0= −0.15A; I_1= −1.5A; T_0= 0.5ms; T_1= 0.5ms; T_2= 0.5ms
   f. Continuous = ON
   g. Press Arb run.

4 Adjust the oscilloscope for a waveform similar to that shown in the following figure.



5 The output voltage should return to within the specified voltage at the specified time following the 50% load change. Check both loading and unloading transients by triggering on the positive and negative slope. Record the voltage at time “t” in the performance test record form under “Transient Response”.

6 *For models N678xA SMU only.* Repeat steps 3 through 5 for the 20 V range. Program the instrument settings as described on the test record form under “Transient Response 20 V”. Change the settings of the N6784A that is being used as the load as follows:
   b. + Voltage limit = 20.4 V
   e. Load pulse properties:
      N678xA: I_0= −0.1 A; I_1= −0.9A; T_0= 1ms; T_1= 1ms; T_2= 1ms

Auxiliary Voltage Measurement Accuracy (N6781A only)

Test category = performance

This test verifies the auxiliary voltage measurement accuracy.

1 Turn off the power system and connect the external DMM and an external power supply to the auxiliary voltage inputs (see Test Setup E).

2 Turn on the external power supply and set the output to 20 volts. Turn on the power system. In Meter View, select Properties, and then select the Aux Voltage measurement input.

3 Record the external DMM reading and the auxiliary DVM readings. The auxiliary voltage reading should be within the designated voltage limit indicated in the test record form under “Auxiliary Voltage Readback”.

4 Reverse the leads of the external power supply and repeat step 3.

Constant Current Tests

NOTE Test each output channel individually. Refer to the appropriate test record form for the instrument settings of the model you are checking.

Current Programming and Readback Accuracy

Test category = performance, calibration

This test verifies that the current programming and measurement functions are within specifications.

1. Turn off the power system and connect the current shunt directly across the output terminals. Connect the DMM directly across the current shunt (see Test Setup B). Note that the electronic load is not used in this portion of the test.
2. Turn on the power system and program the instrument settings as described in the test record form under “Current Programming & Readback, Min Current”. The output status should be “CC”, and the output voltage should be close to zero.
3. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout). Also, record the current measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, Minimum Current”.
4. Program the instrument settings as described in the test record form under “Current Programming & Readback, High Current”.
5. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout). Also, record the current reading measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, High Current”.
6. *For models N6761A and N6762A only.* Connect the Agilent 3458A directly across the output (see Test Setup D without the resistor). Set the Agilent 3458A to the 100 mA range (no autoranging). Set both the current programming and the current measurement functions to the low range. Set the instrument as described under “Current Programming & Readback, Low Current”. Record the current reading of the 3458A. Also, record the current reading measured over the interface. The readings should be within the limits specified under “Current Programming & Readback, Low Range”.
7. *For models N6761A and N6762A with option 2UA only.* Connect the Agilent 3458A and a 20k resistor to the output (see Test Setup D). Set the Agilent 3458A to measure current using the 1 mA range. Set the current measurement to the 200 µA range. Set the instrument as described in the test record form under

"Current Readback, 200 µA Current". Record the current reading of the Agilent 3458A and the current measured over the interface. Readings should be within limits specified for the appropriate model under "Current Readback, 200µA Range".

8 *For models N6763A–N6766A, and N6783A only.* Set the current measurement to the low range. Set the instrument as described under "Current Readback, Low Current". Repeat step 5. Record the current measured over the interface. The readings should be within the limits specified under "Low Current Readback Low Range".

9 *Steps 9 through 13 for models N678xA SMU only.*. Connect the Agilent 3458A directly across the output (see Test Setup D without the resistor). Set the Agilent 3458A to the 100 mA range (no autoranging). Set the current programming to the low ranges - 300 mA for N6781A and N6782A; 100 mA for the N6784A. Set the instrument as described under "Current Programming 300 mA & 100 mA ranges". Record the current readings of the 3458A. The readings should be within the limits specified under "300 mA and 100 mA range Current Iout".

10 Set the current programming to the 10 mA range for the N6784A. Set the instrument as described under "Current Programming 10 mA range". Record the current reading of the 3458A. The reading should be within the limits specified under "10 mA range Current Iout".

11 Connect the Agilent 3458A in series with a 10 Ω resistor to the output (see Test Setup D). Set the Agilent 3458A to measure current using the 100 mA range. Set the current measurement to the 100 mA range. Set the instrument as described under "Current Readback 100 mA Range". Record the current reading of the 3458A and the current measured over the interface. The readings should be within the limits specified under "100 mA Range Readback".

12 Connect the Agilent 3458A in series with a 10 kΩ resistor to the output (see Test Setup D). Set the Agilent 3458A to measure current using the 10 mA range. Set the current measurement to the 1 mA range. Set the instrument as described under "Current Readback 1 mA Range". Record the current reading of the 3458A and the current measured over the interface. The readings should be within the limits specified under "1 mA Range Readback".

13 Connect the Agilent 3458A in series with a 1 MΩ resistor to the output (see Test Setup D). Set the Agilent 3458A to measure current using the 100 µA range. The remote command is "DCI 100e-6". Set the current measurement to the 10 µA range. Set the instrument as described under "Current Readback, 10 µA Range". Record the current reading of the 3458A and the current measured over the interface. The readings should be within the limits specified under "10 µA Range Readback".

CC Load Effect

Test category = performance

This test measures the change in output current resulting from a change in output voltage from full scale to short circuit.

1. Turn off the power system and connect the current shunt, DMM, and electronic load (see Test Setup B). Connect the DMM directly across the current shunt.
2. Turn on the power system and program the instrument settings as described in the test record under “CC Load Effect”.
3. Set the electronic load for CV mode and program it to the output channel’s voltage as described in the test record under “CC Load Effect”. The output status should be “CC”. If it isn’t, adjust the load so that the output voltage drops slightly.
4. Divide the voltage drop (DMM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout).
5. Short the electronic load. For models N6751A and N6752A, wait 10 seconds for the output to stabilize. For models N6761A and N6762A, wait 60 seconds for the output to stabilize. Divide the voltage drop (DMM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout). The difference in the current readings in steps 4 and 5 is the load effect, which should not exceed the value listed in the test record for the appropriate model under “CC Load Effect”.
6. *For models N6781A and N6782A only.* Repeat steps 2 through 5 for the 1 A range and the 300 mA range.
7. *For model N6784A only.* Repeat steps 2 through 5 for the 1 A range, the 100 mA range, and the 10 mA range.

CC Source Effect

Test category = performance

This test measures the change in output current that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

1. Turn off the power system and connect the ac power line through a variable voltage transformer or AC source.
2. Connect the current shunt, DMM, and electronic load (see Test Setup B). Connect the DMM directly across the current shunt. Set the transformer or AC source to nominal line voltage.
3. Turn on the power system and program the instrument settings as described in the test record under “CC Source Effect”.
4. Set the electronic load for the output channel’s voltage under “CC Source Effect”. The output status should be “CC”. If it isn’t, adjust the load so that the output voltage drops slightly.

5 Adjust the AC input to the lowest rated line voltage (86 VAC).

6 Divide the voltage drop (DMM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout).

7 Adjust the AC input to the highest rated line voltage (264 VAC).

8 Divide the voltage drop (DMM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout). The difference between the DMM reading in steps 6 and 8 is the source effect, which should not exceed the value listed in the test record for the appropriate model under "CC Source Effect".

Resistance Programming Accuracy (N6781A only)

Test category = performance, calibration

Note: Current readback accuracy must be verified prior to this test.

1 Connect an external DMM and an electronic load directly to the output (see Test Setup F). Turn on the power system.

2 Set the 20 V range and program the output to 10 V. Turn the output on and record the voltage reading on the DMM. This is the voltage with no load (Vnl).

3 Program the output resistance to 1 ohm. Turn on the electronic load. Select CC mode, current: 1 A, Input On.

4 Record the voltage reading on the DMM. This is the voltage with a load (Vwl). Record the current reading on the front panel of the power system. This is the current with a load (Iwl).

5 Calculate the resistance value as follows: R = (Vnl−Vwl)/Iwl
This is the output resistance, which should not exceed value listed in the test record under "Resistance Programming".

6 Repeat steps 2 through 5 for the 6 V range. Set the output voltage to 6 V and the load current to 3 A.

Negative Current Output (N6783A-BAT and -MFG only)

Test category = performance, calibration

1 Connect the DMM, current shunt, and a power supply to the output (see Test Setup G). Connect plus to plus, minus to minus. Set the external power supply to 3V, 3A.

2 Set the N6783A power module to the values indicted in the test record under "Negative Current Output". The display should read approximately -2 A.

3 Divide the voltage drop (DMM reading) across the current shunt by its resistance to convert to amperes and record this value. The reading should be within the limits specified on the test record under Constant Current Tests, "Negative Current Output".

Test Record Forms

Test Record Form – Agilent N6731B and N6741B

Agilent N6731B and N6741B	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	– 4 mV	_____	+ 34 mV
Voltage measured over interface	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	4.976 V	_____	5.024 V
Voltage measured over interface	Both	Vout – 25 mV	_____	Vout + 25 mV
CV Load Effect				
	Both	– 5 mV	_____	+ 5 mV
CV Source Effect				
	Both	– 1 mV	_____	+ 1 mV
CV Ripple and Noise				
peak-to-peak	N6731B	N/A	_____	+ 10 mV
	N6741B	N/A	_____	+ 20 mV
rms	Both	N/A	_____	+ 2 mV
Transient Response				
Voltage at 200 μs	N6731B	– 80 mV	_____	+ 80 mV
	N6741B	– 100 mV	_____	+ 100 mV
Voltage at 200 μs w/Option 760/761	N6731B	– 100 mV	_____	+ 100 mV
	N6741B	– 125 mV	_____	+ 125 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 40 mA	_____	+ 80 mA
Current measured over interface	Both	Iout – 20 mA	_____	Iout + 20 mA
High Current Iout	N6731B	9.965 A	_____	10.035 A
	N6741B	19.95 A	_____	20.05 A
Current measured over interface	N6731B	Iout – 35 mA	_____	Iout + 35 mA
	N6741B	Iout – 50 mA	_____	Iout + 50 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

Test Description	N6731B Setting	N6741B Setting
Voltage Programming & Readback, Min Voltage	15 mV, 10 A	15 mV, 20 A
Voltage Programming & Readback, High Voltage	5 V, 10 A	5 V, 20 A
CV Load Effect, Source Effect, Ripple and Noise	5 V, 10 A	5 V, 20 A
Transient Response	5 V, from 5 A to 10 A	5 V, from 10 A to 20 A
Current Programming & Readback, Min Current	60 mA, 5 V	60 mA, 5 V
Current Programming & Readback, High Current	10 A, 5 V	20 A, 5 V
CC Load Effect, Source Effect	10 A, 5 V	20 A, 5 V

Test Record Form – Agilent N6732B and N6742B

Agilent N6732B and N6742B	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	– 4 mV	_____	+ 34 mV
Voltage measured over interface	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	7.973 V	_____	8.027 V
Voltage measured over interface	Both	Vout – 28 mV	_____	Vout + 28 mV
CV Load Effect				
	Both	– 6 mV	_____	+ 6 mV
CV Source Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 12 mV
rms	Both	N/A	_____	+ 2 mV
Transient Response				
Voltage at 200 µs	N6732B	– 80 mV	_____	+ 80 mV
	N6742B	– 100 mV	_____	+ 100 mV
Voltage at 200 µs w/Option 760/761	N6732B	– 100 mV	_____	+ 100 mV
	N6742B	– 125 mV	_____	+ 125 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 20 mA	_____	+ 60 mA
Current measured over interface	Both	Iout – 10 mA	_____	Iout + 10 mA
High Current Iout	N6732B	6.2206 A	_____	6.2794 A
	N6742B	12.46 A	_____	12.54 A
Current measured over interface	N6732B	Iout – 19.37 mA	_____	Iout + 19.37 mA
	N6742B	Iout – 29 mA	_____	Iout + 29 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6732B**	**N6742B**
Voltage Programming & Readback, Min Voltage	15 mV, 6.25 A	15 mV, 12.5 A
Voltage Programming & Readback, High Voltage	8 V, 6.25 A	8 V, 12.5 A
CV Load Effect, Source Effect, Ripple and Noise	8 V, 6.25 A	8 V, 12.5 A
Transient Response	8 V, from 3.125 A to 6.25 A	8V, from 6.25A to 12.5A
Current Programming & Readback, Min Current	40 mA, 8 V	40 mA, 8 V
Current Programming & Readback, High Current	6.25 A, 8 V	12.5 A, 8 V
CC Load Effect, Source Effect	6.25 A, 8 V	12.5 A, 8 V

Test Record Form – Agilent N6733B and N6743B

Agilent N6733B and N6743B	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 10 mV	_____	+ 50 mV
Voltage measured over interface	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	19.96 V	_____	20.04 V
Voltage measured over interface	Both	Vout – 40 mV	_____	Vout + 40 mV
CV Load Effect				
	Both	– 9 mV	_____	+ 9 mV
CV Source Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 14 mV
rms	Both	N/A	_____	+ 3 mV
Transient Response				
Voltage at 200 μs	N6733B	– 200 mV	_____	+ 200 mV
	N6743B	– 300 mV	_____	+ 300 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Current measured over interface	Both	Iout – 5 mA	_____	Iout + 5 mA
High Current Iout	N6733B	2.4762 A	_____	2.5237 A
	N6743B	4.9725 A	_____	5.0275 A
Current measured over interface	N6733B	Iout – 8.75 mA	_____	Iout + 8.75 mA
	N6743B	Iout – 12.5 mA	_____	Iout + 12.5 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6733B**	**N6743B**
Voltage Programming & Readback, Min Voltage	30 mV, 2.5 A	30 mV, 5 A
Voltage Programming & Readback, High Voltage	20 V, 2.5 A	20 V, 5 A
CV Load Effect, Source Effect, Ripple and Noise	20 V, 2.5 A	20 V, 5 A
Transient Response	20 V, from 1.25 A to 2.5 A	20 V, from 2.5 A to 5 A
Current Programming & Readback, Min Current	10 mA, 20 V	10 mA, 20 V
Current Programming & Readback, High Current	2.5 A, 20 V	5 A, 20 V
CC Load Effect, Source Effect	2.5 A, 20 V	5 A, 20 V

Test Record Form – Agilent N6734B and N6744B

Agilent N6734B and N6744B	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 5 mV	_____	+ 75 mV
Voltage measured over interface	Both	Vout – 35 mV	_____	Vout + 35 mV
High Voltage Vout	Both	34.93 V	_____	35.07 V
Voltage measured over interface	Both	Vout – 70 mV	_____	Vout + 70 mV
CV Load Effect				
	Both	– 11 mV	_____	+ 11 mV
CV Source Effect				
	Both	– 4 mV	_____	+ 4 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 15 mV
rms	Both	N/A	_____	+ 5 mV
Transient Response				
Voltage at 200 µs	N6734B	– 200 mV	_____	+ 200 mV
	N6744B	– 300 mV	_____	+ 300 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 15 mA	_____	+ 25 mA
Current measured over interface	Both	Iout – 4 mA	_____	Iout + 4 mA
High Current Iout	N6734B	1.47775 A	_____	1.52225 A
	N6744B	2.9755 A	_____	3.0245 A
Current measured over interface	N6734B	Iout – 6.25 mA	_____	Iout + 6.25 mA
	N6744B	Iout – 8.5 mA	_____	Iout + 8.5 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6734B**	**N6744B**
Voltage Programming & Readback, Min Voltage	40 mV, 1.5 A	40 mV, 3 A
Voltage Programming & Readback, High Voltage	35 V, 1.5 A	35 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise	35 V, 1.5 A	35 V, 3 A
Transient Response	35 V, from 0.75 A to 1.5 A	35 V, from 1.5 A to 3 A
Current Programming & Readback, Min Current	5 mA, 35 V	5 mA, 35 V
Current Programming & Readback, High Current	1.5 A, 35 V	3 A, 35 V
CC Load Effect, Source Effect	1.5 A, 35 V	3 A, 35 V

Test Record Form – Agilent N6735B and N6745B

Agilent N6735B and N6745B	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 10 mV	_____	+ 130 mV
Voltage measured over interface	Both	Vout – 60 mV	_____	Vout + 60 mV
High Voltage Vout	Both	59.88 V	_____	60.12 V
Voltage measured over interface	Both	Vout – 120 mV	_____	Vout + 120 mV
CV Load Effect				
	N6735B	– 13 mV	_____	+ 13 mV
	N6745B	– 16 mV	_____	+ 16 mV
CV Source Effect				
	Both	– 6 mV	_____	+ 6 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 25 mV
rms	Both	N/A	_____	+ 9 mV
Transient Response				
Voltage at 200 μs	N6735B	– 400 mV	_____	+ 400 mV
	N6745B	– 500 mV	_____	+ 500 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 17.5 mA	_____	+ 22.5 mA
Current measured over interface	Both	Iout – 4 mA	_____	Iout + 4 mA
High Current Iout	N6735B	0.7788 A	_____	0.8212 A
	N6745B	1.5776 A	_____	1.6224 A
Current measured over interface	N6735B	Iout – 5.2 mA	_____	Iout + 5.2 mA
	N6745B	Iout – 6.4 mA	_____	Iout + 6.4 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6735B**	**N6745B**
Voltage Programming & Readback, Min Voltage	70 mV, 0.8 A	70 mV, 1.6 A
Voltage Programming & Readback, High Voltage	60 V, 0.8 A	60 V, 1.6 A
CV Load Effect, Source Effect, Ripple and Noise	60 V, 0.8 A	60 V, 1.6 A
Transient Response	60 V, from 0.4 A to 0.8 A	60 V, from 0.8 A to 1.6 A
Current Programming & Readback, Min Current	2.5 mA, 60 V	2.5 mA, 60 V
Current Programming & Readback, High Current	0.8 A, 60 V	1.6 A, 60 V
CC Load Effect, Source Effect	0.8 A, 60 V	1.6 A, 60 V

Test Record Form – Agilent N6736B and N6746B

Agilent N6736B and N6746B	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	0 mV	_____	+ 200 mV
Voltage measured over interface	Both	Vout – 100 mV	_____	Vout + 100 mV
High Voltage Vout	Both	99.8 V	_____	100.2 V
Voltage measured over interface	Both	Vout – 200 mV	_____	Vout + 200 mV
CV Load Effect				
	N6736B	– 20 mV	_____	+ 20 mV
	N6746B	– 30 mV	_____	+ 30 mV
CV Source Effect				
	Both	– 10 mV	_____	+ 10 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 30 mV
rms	Both	N/A	_____	+ 18 mV
Transient Response				
Voltage at 200 μs	N6736B	– 500 mV	_____	+ 500 mV
	N6746B	– 1000 mV	_____	+ 1000 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 8.5 mA	_____	+ 11.5 mA
Current measured over interface	Both	Iout – 2 mA	_____	Iout + 2 mA
High Current Iout	N6736B	0.4893 A	_____	0.5107 A
	N6746B	0.9885 A	_____	1.0115 A
Current measured over interface	N6736B	Iout – 2.75 mA	_____	Iout + 2.75 mA
	N6746B	Iout – 3.5 mA	_____	Iout + 3.5 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6736B**	**N6746B**
Voltage Programming & Readback, Min Voltage	100 mV, 0.5 A	100 mV, 1 A
Voltage Programming & Readback, High Voltage	100 V, 0.5 A	100 V, 1 A
CV Load Effect, Source Effect, Ripple and Noise	100 V, 0.5 A	100 V, 1 A
Transient Response	100 V, from 0.25 A to 0.5 A	100 V, from 0.5 A to 1 A
Current Programming & Readback, Min Current	1.5 mA, 100 V	1.5 mA, 100 V
Current Programming & Readback, High Current	0.5 A, 100 V	1 A, 100 V
CC Load Effect, Source Effect	0.5 A, 100 V	1 A, 100 V

Test Record Form – Agilent N6751A and N6752A

Agilent N6751A and N6752A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 1 mV	_____	+ 39 mV
Voltage measured over interface	Both	Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout	Both	49.951 V	_____	50.049 V
Voltage measured over interface	Both	Vout – 45 mV	_____	Vout + 45 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 1 mV	_____	+ 1 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 4.5 mV
rms	Both	N/A	_____	+ 0.35 mV
Transient Response				
Voltage at 100 µs	Both	– 75 mV	_____	+ 75 mV
Voltage at 100 µs with Option 761	N6752A	– 125 mV	_____	+ 125 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	– 10 mA	_____	+ 30 mA
Current measured over interface	Both	Iout – 4 mA	_____	Iout + 4 mA
High Current Iout	N6751A	4.975 A	_____	5.025 A
	N6752A	9.970 A	_____	10.030 A
Current measured over interface	N6751A	Iout – 9 mA	_____	Iout + 9 mA
	N6752A	Iout – 14 mA	_____	Iout + 14 mA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA

	Instrument Settings	
Test Description	**N6751A**	**N6752A**
Voltage Programming & Readback, Min Voltage	20 mV, 1 A	20 mV, 2 A
Voltage Programming & Readback, High Voltage	50 V, 1 A	50 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise	50 V, 1 A	50 V, 2 A
Transient Response	10 V, from 3 A to 5 A	8.5 V, from 5 A to 10 A
Current Programming & Readback, Min Current	10 mA, 10 V	10 mA, 8.5 V
Current Programming & Readback, High Current	5 A, 10 V	10 A, 8.5 V
CC Load Effect, Source Effect	5 A, 10 V	10 A, 8.5 V

Test Record Form – Agilent N6753A and N6755A

Agilent N6753A and N6755A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	0 mV	_____	+ 20 mV
Voltage measured over interface	Both	Vout – 10 mV	_____	Vout + 10 mV
High Voltage Vout	Both	19.978 V	_____	20.022 V
Voltage measured over interface	Both	Vout –20 mV	_____	Vout + 20 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 5 mV
rms	Both	N/A	_____	+ 1 mV
Transient Response				
Voltage at 100 µs	Both	– 30 mV	_____	+ 30 mV
Voltage at 100 µs w/Option 760/761	Both	– 200 mV	_____	+ 200 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 20 mA	_____	+ 80 mA
Current measured over interface	Both	Iout – 30 mA	_____	Iout + 30 mA
High Current Iout	Both	49.920 A	_____	50.080 A
Current measured over interface	Both	Iout – 80 mA	_____	Iout + 80 mA
CC Load Effect				
	Both	– 12 mA	_____	+ 12 mA
CC Source Effect				
	Both	– 5 mA	_____	+ 5 mA

	Instrument Settings	
Test Description	**N6753A**	**N6755A**
Voltage Programming & Readback, Min Voltage	10 mV, 15 A	10 mV, 25 A
Voltage Programming & Readback, High Voltage	20 V, 15 A	20 V, 25 A
CV Load Effect, Source Effect, Ripple and Noise	20 V, 15 A	20 V, 25 A
Transient Response	6 V, from 25 A to 50 A	10 V, from 25 A to 50 A
Current Programming & Readback, Min Current	50 mA, 6 V	50 mA, 10 V
Current Programming & Readback, High Current	50 A, 6 V	50 A, 10 V
CC Load Effect, Source Effect	50 A, 6 V	50 A, 10 V

Test Record Form – Agilent N6754A and N6756A

Agilent N6754A and N6756A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	0 mV	_____	+ 50 mV
Voltage measured over interface	Both	Vout – 25 mV	_____	Vout + 25 mV
High Voltage Vout	Both	59.939 V	_____	60.061 V
Voltage measured over interface	Both	Vout – 55 mV	_____	Vout + 55 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 1.2 mV	_____	+ 1.2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 6 mV
rms	Both	N/A	_____	+ 1 mV
Transient Response				
Voltage at 100 µs	Both	– 90 mV	_____	+ 90 mV
Voltage at 100 µs w/Option 760/761	Both	– 350 mV	_____	+ 350 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 8 mA	_____	+ 32 mA
Current measured over interface	Both	Iout – 8 mA	_____	Iout + 8 mA
High Current Iout	N6754A	19.968 A	_____	20.032 A
	N6756A	16.071 A	_____	17.029 A
Current measured over interface	N6754A	Iout – 28 mA		Iout + 28 mA
	N6756A	Iout – 25 mA		Iout + 25 mA
CC Load Effect				
	Both	– 5 mA	_____	+ 5 mA
CC Source Effect				
	Both	– 2 mA	_____	+ 2 mA

	Instrument Settings	
Test Description	**N6754A**	**N6756A**
Voltage Programming & Readback, Min Voltage	25 mV, 5 A	25 mV, 8.33 A
Voltage Programming & Readback, High Voltage	60 V, 5 A	60 V, 8.33 A
CV Load Effect, Source Effect, Ripple and Noise	60 V, 5 A	60 V, 8.33 A
Transient Response	15 V, from 10 A to 20 A	29 V, from 8.5 A to 17 A
Current Programming & Readback, Min Current	20 mA, 15 V	20 mA, 29 V
Current Programming & Readback, High Current	20 A, 15 V	17 A, 29 V
CC Load Effect, Source Effect	20 A, 15 V	17 A, 29 V

Test Record Form – Agilent N6761A and N6762A

Agilent N6761A and N6762A Description	Report No _____ Model	Minimum Specs.	Date _____ Results	Maximum Specs.
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 9 mV	_____	+ 21 mV
Voltage measured over interface	Both	Vout – 6 mV	_____	Vout + 6 mV
High Voltage Vout	Both	49.986 V	_____	50.014 V
Voltage measured over interface	Both	Vout – 14 mV	_____	Vout + 14 mV
Low Range Voltage Prog. & Readback				
Low Voltage Vout	Both	5.4976 V	_____	5.5024 V
Voltage measured over interface	Both	Vout – 2.4 mV	_____	Vout + 2.4 mV
CV Load Effect				
	Both	– 0.5 mV	_____	+ 0.5 mV
CV Source Effect				
	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 4.5 mV
rms	Both	N/A	_____	+ 0.35 mV
Transient Response				
Voltage at 150 µs	Both	– 75 mV	_____	+ 75 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 0.8 mA	_____	+ 1.2 mA
Current measured over interface	Both	Iout – 160 µA	_____	Iout + 160 µA
High Current Iout	N6761A	1.4992 A	_____	1.5008 A
	N6762A	2.9986 A	_____	3.0014 A
Current measured over interface	N6761A	Iout – 0.76 mA	_____	Iout + 0.76 mA
	N6762A	Iout – 1.36 mA	_____	Iout + 1.36 mA
Low Range Current Prog. & Readback				
Low Current (Full Scale) Iout	Both	0.099930 A	_____	0.100070 A
Current measured over interface	Both	Iout – 45 µA	_____	Iout + 45 µA
Current Readback				
100µA current measured over interface	Both	Iout – 0.6 µA	_____	Iout + 0.6 µA
200µA current measured over interface	Both	Iout – 1.1 µA	_____	Iout + 1.1 µA
CC Load Effect				
	Both	– 65 µA	_____	+ 65 µA
CC Source Effect				
	Both	– 30 µA	_____	+ 30 µA

Test Description	N6761A Settings	N6762A Settings
Voltage Programming & Readback, Min Voltage	15 mV, 1 A	15 mV, 2 A
Voltage Programming & Readback, High Voltage	50 V, 1 A	50 V, 2 A
Voltage Programming & Readback, Low Voltage	5.5 V, 1 A	5.5 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise	50 V, 1 A	50 V, 2 A
Transient Response	33 V, from 0.9 A to 1.5 A	33 V, from 1.5 A to 3 A
Current Programming & Readback, Min Current	1 mA, 33 V	1 mA, 33 V
Current Programming & Readback, High Current	1.5 A, 33 V	3 A, 33 V
Current Programming & Readback, Low Current	0.1 A, 33 V	0.1 A, 33 V
Current Readback, 100 µA Current	1 mA, 1.9 V	1 mA, 1.9 V
Current Readback, 200 µA Current	1 mA, 3.9 V	1 mA, 3.9 V
CC Load Effect, Source Effect	1.5 A, 33 V	3 A, 33 V

Test Record Form – Agilent N6763A and N6765A

Agilent N6763A and N6765A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 5 mV	_____	+ 15 mV
Voltage measured over interface	Both	Vout – 10 mV	_____	Vout + 10 mV
High Voltage Vout	Both	19.989 V	_____	20.011 V
Voltage measured over interface	Both	Vout – 16 mV	_____	Vout + 16 mV
Low Voltage measured over interface	Both	Vout – 2.1 mV	_____	Vout + 2.1 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 5 mV
rms	Both	N/A	_____	+ 1 mV
Transient Response				
Voltage at 100 μs	Both	– 30 mV	_____	+ 30 mV
Voltage at 100 μs w/Option 760/761	Both	– 200 mV	_____	+ 200 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 35 mA	_____	+ 65 mA
Current measured over interface	Both	Iout – 60 mA	_____	Iout + 60 mA
High Current Iout	Both	49.935 A	_____	50.065 A
Current measured over interface	Both	Iout – 60 mA	_____	Iout + 60 mA
Low Current measured over interface	Both	Iout – 1.85 mA	_____	Iout + 1.85 mA
CC Load Effect				
	Both	– 12 mA	_____	+ 12 mA
CC Source Effect				
	Both	– 5 mA	_____	+ 5 mA

	Instrument Settings	
Test Description	**N6763A**	**N6765A**
Voltage Programming & Readback, Min Voltage	10 mV, 15 A	10 mV, 25 A
Voltage Programming & Readback, High Voltage	20 V, 15 A	20 V, 25 A
Voltage Readback, Low	2 V, 15 A	2 V, 25 A
CV Load Effect, Source Effect, Ripple and Noise	20 V, 15 A	20 V, 25 A
Transient Response	6 V, from 25 A to 50 A	10 V, from 25 A to 50 A
Current Programming & Readback, Min Current	50 mA, 6 V	50 mA, 10 V
Current Programming & Readback, High Current	50 A, 6 V	50 A, 10 V
Current Readback, Low	1.5 A, 6 V	1.5 A, 10 V
CC Load Effect, Source Effect	50 A, 6 V	50 A, 10 V

Test Record Form – Agilent N6764A and N6766A

Agilent N6764A and N6766A Description	Model	Minimum Specs.	Results	Maximum Specs.
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+ 13 mV	_____	+ 37 mV
Voltage measured over interface	Both	Vout – 25 mV	_____	Vout + 25 mV
High Voltage Vout	Both	59.970 V	_____	60.030 V
Voltage measured over interface	Both	Vout – 43 mV	_____	Vout + 43 mV
Low Voltage measured over interface	Both	Vout – 6.8 mV	_____	Vout + 6.8 mV
CV Load Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Source Effect				
	Both	– 1.2 mV	_____	+ 1.2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 6 mV
rms	Both	N/A	_____	+ 1 mV
Transient Response				
Voltage at 100 µs	Both	– 90 mV	_____	+ 90 mV
Voltage at 100 µs w/Option 760/761	Both	– 350 mV	_____	+ 350 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 16 mA	_____	+ 24 mA
Current measured over interface	Both	Iout – 5 mA	_____	Iout + 5 mA
High Current Iout	N6764A	19.981 A	_____	20.019 A
	N6766A	16.9833 A	_____	17.0167 A
Current measured over interface	N6764A	Iout – 25 mA	_____	Iout + 25 mA
	N6766A	Iout – 22 mA	_____	Iout + 22 mA
Low Current measured over interface	Both	Iout – 1 mA	_____	Iout + 1 mA
CC Load Effect				
	Both	– 5 mA	_____	+ 5 mA
CC Source Effect				
	Both	– 2 mA	_____	+ 2 mA

	Instrument Settings	
Test Description	**N6764A**	**N6766A**
Voltage Programming & Readback, Min Voltage	25 mV, 5 A	25 mV, 8.33 A
Voltage Programming & Readback, High Voltage	60 V, 5 A	60 V, 8.33 A
Voltage Readback, Low	6 V, 5 A	6 V, 8.33 A
CV Load Effect, Source Effect, Ripple and Noise	60 V, 5 A	60 V, 8.33 A
Transient Response	15 V, from 10 A to 20 A	29 V, from 8.5 A to 17 A
Current Programming & Readback, Min Current	20 mA, 15 V	20 mA, 29 V
Current Programming & Readback, High Current	20 A, 15 V	17 A, 29 V
Current Readback, Low	0.5 A, 15 V	0.5 A, 29 V
CC Load Effect, Source Effect	20 A, 15 V	17 A, 29 V

Test Record Form – Agilent N6773A

Agilent Model N6773A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum Voltage Vout		+ 10 mV	_____	+ 50 mV
Voltage measured over interface		Vout – 20 mV	_____	Vout + 20 mV
High Voltage Vout		19.96 V	_____	20.04 V
Voltage measured over interface		Vout – 40 mV	_____	Vout + 40 mV
CV Load Effect				
		– 13 mV	_____	+ 13 mV
CV Source Effect				
		– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak		N/A	_____	+ 20 mV
rms		N/A	_____	+ 3 mV
Transient Response				
Voltage at 250 µs		– 300 mV	_____	+ 300 mV
Voltage at 250 µs w/Option 760/761		– 350 mV	_____	+ 350 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum Current Iout		– 30 mA	_____	+ 90 mA
Current measured over interface		Iout – 15 mA	_____	Iout + 15 mA
High Current Iout		14.9175 A	_____	15.0825 A
Current measured over interface		Iout – 37.5 mA	_____	Iout + 37.5 mA
CC Load Effect				
		– 6 mA	_____	+ 6 mA
CC Source Effect				
		– 1 mA	_____	+ 1 mA

Test Description	N6773A Setting
Voltage Programming & Readback, Min	30 mV, 15 A
Voltage Programming & Readback, High	20 V, 15 A
CV Load Effect, Source Effect, Ripple and Noise	20 V, 15 A
Transient Response	20 V, from 7.5 A to 15 A
Current Programming & Readback, Min	30 mA, 20 V
Current Programming & Readback, High	15 A, 20 V
CC Load Effect, Source Effect	15 A, 20 V

Test Record Form – Agilent N6774A

Agilent Model N6774A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum Voltage Vout		+ 5 mV	_____	+ 75 mV
Voltage measured over interface		Vout – 35 mV	_____	Vout + 35 mV
High Voltage Vout		34.93 V	_____	35.07 V
Voltage measured over interface		Vout – 70 mV	_____	Vout + 70 mV
CV Load Effect				
		– 16 mV	_____	+ 16 mV
CV Source Effect				
		– 4 mV	_____	+ 4 mV
CV Ripple and Noise				
peak-to-peak		N/A	_____	+ 22 mV
rms		N/A	_____	+ 5 mV
Transient Response				
Voltage at 250 µs		– 300 mV	_____	+ 300 mV
Voltage at 250 µs w/Option 760/761		– 350 mV	_____	+ 350 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum Current Iout		– 45 mA	_____	+ 75 mA
Current measured over interface		Iout – 12 mA	_____	Iout + 12 mA
High Current Iout		8.42725 A	_____	8.57275 A
Current measured over interface		Iout – 24.75 mA	_____	Iout + 24.75 mA
CC Load Effect				
		– 6 mA	_____	+ 6 mA
CC Source Effect				
		– 1 mA	_____	+ 1 mA

Test Description	N6774A Setting
Voltage Programming & Readback, Min	40 mV, 8.5 A
Voltage Programming & Readback, High	35 V, 8.5 A
CV Load Effect, Source Effect, Ripple and Noise	35 V, 8.5 A
Transient Response	35 V, from 4.25 A to 8.5 A
Current Programming & Readback, Min	15 mA, 35 V
Current Programming & Readback, High	8.5 A, 35 V
CC Load Effect, Source Effect	8.5 A, 35 V

Test Record Form – Agilent N6775A

Agilent Model N6775A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout		+ 10 mV	_____	+ 130 mV
Voltage measured over interface		Vout – 60 mV	_____	Vout + 60 mV
High Voltage Vout		59.88 V	_____	60.12 V
Voltage measured over interface		Vout – 120 mV	_____	Vout + 120 mV
CV Load Effect				
		– 24 mV	_____	+ 24 mV
CV Source Effect				
		– 6 mV	_____	+ 6 mV
CV Ripple and Noise				
peak-to-peak		N/A	_____	+ 35 mV
rms		N/A	_____	+ 9 mV
Transient Response				
Voltage at 250 μs		– 500 mV	_____	+ 500 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout		– 52.5 mA	_____	+ 67.5 mA
Current measured over interface		Iout – 12 mA	_____	Iout + 12 mA
High Current Iout		4.9325 A	_____	5.0675 A
Current measured over interface		Iout – 19.5 mA	_____	Iout + 19.5 mA
CC Load Effect				
		– 6 mA	_____	+ 6 mA
CC Source Effect				
		– 1 mA	_____	+ 1 mA

Test Description	N6775A Setting
Voltage Programming & Readback, Min	70 mV, 5 A
Voltage Programming & Readback, High	60 V, 5 A
CV Load Effect, Source Effect, Ripple and Noise	60 V, 5 A
Transient Response	60 V, from 2.5 A to 5 A
Current Programming & Readback, Min	7.5 mA, 60 V
Current Programming & Readback, High	5 A, 60 V
CC Load Effect, Source Effect	5 A, 60 V

Test Record Form – Agilent N6776A

Agilent Model N6776A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout		0 mV	_____	+ 200 mV
Voltage measured over interface		Vout – 100 mV	_____	Vout + 100 mV
High Voltage Vout		99.8 V	_____	100.2 V
Voltage measured over interface		Vout – 200 mV	_____	Vout + 200 mV
CV Load Effect				
		– 45 mV	_____	+ 45 mV
CV Source Effect				
		– 10 mV	_____	+ 10 mV
CV Ripple and Noise				
peak-to-peak		N/A	_____	+ 45 mV
rms		N/A	_____	+ 18 mV
Transient Response				
Voltage at 250 μs		– 1000 mV	_____	+ 1000 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout		– 25.5 mA	_____	+ 34.5 mA
Current measured over interface		Iout – 6 mA	_____	Iout + 6 mA
High Current Iout		2.9655 A	_____	3.0345 A
Current measured over interface		Iout – 10.5 mA	_____	Iout + 10.5 mA
CC Load Effect				
		– 6 mA	_____	+ 6 mA
CC Source Effect				
		– 1 mA	_____	+ 1 mA

Test Description	N6776A Setting
Voltage Programming & Readback, Min	100 mV, 3 A
Voltage Programming & Readback, High	100 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise	100 V, 3 A
Transient Response	100 V, from 1.5 A to 3 A
Current Programming & Readback, Min	4.5 mA, 100 V
Current Programming & Readback, High	3 A, 100 V
CC Load Effect, Source Effect	3 A, 100 V

Test Record Form – Agilent N6777A

Agilent Model N6777A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum Voltage Vout		0 mV	_____	+ 300 mV
Voltage measured over interface		Vout – 150 mV	_____	Vout + 150 mV
High Voltage Vout		149.7 V	_____	150.3 V
Voltage measured over interface		Vout – 300 mV	_____	Vout + 300 mV
CV Load Effect				
		– 68 mV	_____	+ 68 mV
CV Source Effect				
		– 15 mV	_____	+ 15 mV
CV Ripple and Noise				
peak-to-peak		N/A	_____	+ 68 mV
rms		N/A	_____	+ 27 mV
Transient Response				
Voltage at 250 μs		– 2.0 V	_____	+ 2.0 V
		Constant Current Tests		
Current Programming & Readback				
Minimum Current Iout		– 27 mA	_____	+ 33 mA
Current measured over interface		Iout – 6 mA	_____	Iout + 6 mA
High Current Iout		1.967 A	_____	2.033 A
Current measured over interface		Iout – 9 mA	_____	Iout + 9 mA
CC Load Effect				
		– 6 mA	_____	+ 6 mA
CC Source Effect				
		– 1 mA	_____	+ 1 mA

Test Description	N6777A Setting
Voltage Programming & Readback, Min	150 mV, 2 A
Voltage Programming & Readback, High	150 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise	150 V, 2 A
Transient Response	150 V, from 1 A to 2 A
Current Programming & Readback, Min	3 mA, 150 V
Current Programming & Readback, High	2 A, 150 V
CC Load Effect, Source Effect	2 A, 150 V

Test Record Form – Agilent N6781A, N6782A, and N6784A SMU

Agilent N6781A, N6782A and N6784A	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum Voltage Vout	All	– 1.8 mV	_____	+ 1.8 mV
Voltage measured over interface	All	Vout – 1.2 mV	_____	Vout + 1.2 mV
High Voltage Vout	All	19.9932 V	_____	20.0068 V
Voltage measured over interface	All	Vout – 6.2 mV	_____	Vout + 6.2 mV
Voltage Prog. & Readback Low Range				
1 V Voltage Vout	All	0.99915 V	_____	1.00085 V
Voltage measured over interface	All	Vout – 325 µV	_____	Vout + 325 µV
600 mV Prog. & 100 mV Readback				
100 mV Voltage Vout	All	99.775 mV	_____	100.225 mV
Voltage measured over interface	All	Vout – 75 µV	_____	Vout + 75 µV
CV Load Effect				
20 V output range	All	– 700 µV	_____	+ 700 µV
6 V output range	All	– 400 µV	_____	+ 400 µV
CV Source Effect	All	– 300 µV	_____	+ 300 µV
CV Ripple and Noise				
peak-to-peak 20 V output range	All	N/A	_____	+ 12 mV
rms 20 V output range	All	N/A	_____	+ 1.2 mV
peak-to-peak 6 V output range	All	N/A	_____	+ 12 mV
rms 6 V output range	All	N/A	_____	+ 1.2 mV
Transient Response				
6 V output range at 35 µs	All	– 20 mV	_____	+ 20 mV
20 V output range at 35 µs	All	– 10 mV	_____	+ 10 mV
Auxiliary Voltage Readback	N6781A	Vout – 10 mV	_____	Vout + 10 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum Current Iout	All	– 300 µA	_____	+ 300 µA
Current measured over interface	All	Iout – 250 µA	_____	Iout + 250 µA
High Current Iout	All	2.9985 A	_____	3.0015 A
Current measured over interface	All	Iout – 1.15 mA	_____	Iout + 1.15 mA
300 mA, 100 mA, 10 mA Programming				
300 mA range Current Iout	N6781/82A	99.82 mA	_____	100.18 mA
100 mA range Current Iout	N6784A	99.958 mA	_____	100.042 mA
10 mA range Current Iout	N6784A	9.9925 mA	_____	10.0075 mA
100 mA, 1 mA, 10 µA Readback				
300 mA range measured over interface	All	Iout – 35 µA	_____	Iout + 35 µA
1 mA range measured over interface	All	Iout – 350 nA	_____	Iout + 350 nA
(when installed in N6705A mainframe)		(Iout – 360 nA)	(_____)	(Iout + 360 nA)
10 µA range measured over interface	All	Iout – 10.5 nA	_____	Iout + 10.5 nA
(when installed in N6705A mainframe)		(Iout – 22.5 nA)	(_____)	(Iout + 22.5 nA)

Agilent N678xA SMU Test Record Card (continued)

Constant Current Tests - continued				
CC Load Effect				
3 A output range	All	– 100 µA	_____	+ 100 µA
1 A output range	All	– 50 µA	_____	+ 50 µA
300 mA output range	N6781/82A	– 50 µA	_____	+ 50 µA
100 mA & 10 mA output ranges	N6784A	– 5 µA	_____	+ 5 µA
CC Source Effect	All	– 60 µA	_____	+ 60 µA
N6781A Resistance Tests				
Resistance Programming				
20 V output range	N6781A	0.996 Ω	_____	1.004 Ω
6 V output range	N6781A	0.9975 Ω	_____	1.0025 Ω

Instrument Settings – Agilent N678xA SMU

Test Description	N6781A, N6782A, and N6784A Settings
Voltage Programming & Readback, Min Voltage	Voltage Priority; 0 V, 1 A
Voltage Programming & Readback, High Voltage	Voltage Priority; 20 V, 1 A
Voltage Programming & Readback, Low Voltage	Voltage Priority; 1 V, 1 A
600 mV Programming & 100 mV Readback	Voltage Priority; 0.1 V, 1 A
CV Load Effect, 20 V range	Voltage Priority; 20 V, 1 A
CV Load Effect, 6 V range	Voltage Priority; 6 V, 3 A
CV Load Effect, 600 mV range	Voltage Priority; 100 mV, 3 A
CV Source Effect	Voltage Priority; 20 V, 1 A
CV Ripple and Noise, 20 V range	Voltage Priority; 20 V, 1 A
CV Ripple and Noise, 6 V range	Voltage Priority; 6 V, 3 A
Transient Response, 6 V range	Voltage Priority; Comp.= HIGH3; 6V, from 0.1 to 1.5 A
Transient Response, 20 V range	Voltage Priority; Comp.= HIGH3; 20V, from 0.1 to 0.9 A
Current Programming & Readback, Min Current	Current Priority; 0 A, 6 V
Current Programming & Readback, High Current	Current Priority; 3 A, 6 V
Current Programming 300 mA & 100 mA ranges	Current Priority; 100 mA, 20 V
Current Programming 10 mA range	Current Priority; 10 mA, 20 V
Current Readback 100 mA range	Voltage Priority; 100 mA, 1 V
Current Readback 1 mA Range	Voltage Priority; 1 mA, 10 V
Current Readback 10 µA Range	Voltage Priority; 10 µA, 10 V
CC Load Effect, 3 A range	Current Priority; 3 A, 6 V
CC Load Effect, 1 A range	Current Priority; 1 A, 6 V
CC Load Effect, 300 mA range	Current Priority; 100 mA, 6 V
CC Load Effect, 100 mA range	Current Priority; 100 mA, 6 V
CC Load Effect, 10 mA range	Current Priority; 10 mA, 6 V
CC Source Effect	Current Priority; 3 A, 6 V
N6781A Resistance Programming, 20 V range	Voltage Priority; 10 V, 1 Ω (Elect. load: CC mode, 20 V, 1A)
N6781A Resistance Programming, 6 V range	Voltage Priority; 6 V, 1 Ω (Elect. load: CC mode, 20 V, 3A)

Test Record Form – Agilent N6783A-BAT and N6783A-MFG

Agilent N6783A-BAT, N6783A-MFG	Report No _____		Date _____	
Description	**Model**	**Minimum Specs.**	**Results**	**Maximum Specs.**
	Constant Voltage Tests			
Voltage Programming & Readback				
Minimum Voltage Vout	Both	+5 mV	_____	+25 mV
Voltage measured over interface	Both	Vout – 5 mV	_____	Vout + 5 mV
High Voltage Vout	N6783A-BAT	7.982 V	_____	8.018 V
	N6783A-MFG	5.984 V	_____	6.016 V
Voltage measured over interface	N6783A-BAT	Vout – 9 mV	_____	Vout – 9 mV
	N6783A-MFG	Vout – 8 mV	_____	Vout + 8 mV
CV Load Effect				
	Both	– 6 mV	_____	+ 6 mV
CV Source Effect				
	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak	Both	N/A	_____	+ 8 mV
rms		N/A	_____	+ 1.5 mV
Transient Response 6 V				
Voltage at 45 µs	Both	– 75 mV	_____	+ 75 mV
Voltage at 75 µs with Option 761	Both	– 90 mV	_____	+ 90 mV
	Constant Current Tests			
Current Programming & Readback				
Minimum Current Iout	Both	+ 3.2 mA	_____	+ 6.8 mA
Current measured over interface	Both	Iout – 0.6 mA	_____	Iout + 0.6 mA
High Current Iout	Both	2.9952 A	_____	3.0048 A
Current measured over interface	Both	Iout – 3.6 mA	_____	Iout + 3.6 mA
Low Current measured over interface	Both	Iout – 225 µA	_____	Iout + 225 µA
CC Load Effect				
	Both	– 2 mA	_____	+ 2 mA
CC Source Effect				
	Both	– 1 mA	_____	+ 1 mA
Negative Current Output				
	Both	– 1.9942 A	_____	– 2.0058 A

Test Description	N6783A-BAT Setting	N6783A-MFG Setting
Voltage Programming & Readback, Min	15 mV, 3 A	15 mV, 3 A
Voltage Programming & Readback, High	8 V, 3 A	6 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise	8 V, 3 A	6 V, 3 A
Transient Response 6 V	6 V, from 0.15 A to 1.5 A	6 V, from 0.15 A to 1.5 A
Current Programming & Readback, Min	5 mA, 8 V	5 mA, 6 V
Current Programming & Readback, High	3 A, 8 V	3 A, 6 V
Current Readback, Low	150 mA, 8 V	150 mA, 6 V
CC Load Effect, Source Effect	3 A, 8 V	3 A, 6 V
Negative Current Output	0 V, –2A	0 V, –2A

3
Calibration

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This chapter includes calibration procedures for the Agilent N6700 Modular Power System. Instructions are given for performing the procedures from either the front panel or a controller over the GPIB.

Refer to the “Equipment Required” section in chapter 2 for a list of the equipment required for calibration. Also refer to “Measurement Techniques” for information about connecting the voltmeter and current shunt.

NOTE Perform the verification tests before calibrating your power system. If the power system passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.

Calibration Interval

The recommended calibration interval for Agilent N6700 Series power modules is one year. Agilent N6700A/B, N6701A, and N6702A MPS mainframes do not require calibration.

Calibration Description

Refer to the “Equipment Required” section in chapter 2 for a list of the equipment required for calibration. Also refer to “Measurement Techniques” for information about connecting the voltmeter and current shunt. Additional information about calibration follows:

- The correct password is required to enter the Admin menu, which contains the calibration function. The password is factory-set to 0 (zero). You can change the password once calibration mode is entered to prevent unauthorized access to the calibration mode. Refer to “Change the Calibration Password” at the end of this section.
- Calibrate only ONE channel at a time. The calibration commands accept only a single channel number for the channel parameter. Calibration cannot be performed on channels that have been grouped. If any channels have been grouped, they must be ungrouped before they can be calibrated.
- When calibrating the unit using SCPI commands, most steps involve sending a *OPC? query to synchronize with the power system’s command completion before proceeding. The response from the instrument must be read each time *OPC? is given. In some steps, it may take up to 30 seconds for *OPC? to respond.
- **Once started, you must perform the complete calibration procedure in its entirety.** As each calibration section is completed, the instrument calculates new calibration constants and begins using them. However, these constants are not saved in nonvolatile memory until a SAVE command is explicitly given.
- Exit the calibration mode either by logging out of the Admin menu or by sending CAL:STAT OFF. Note that any channels that were calibrated but not saved will revert to their previous calibration constants.

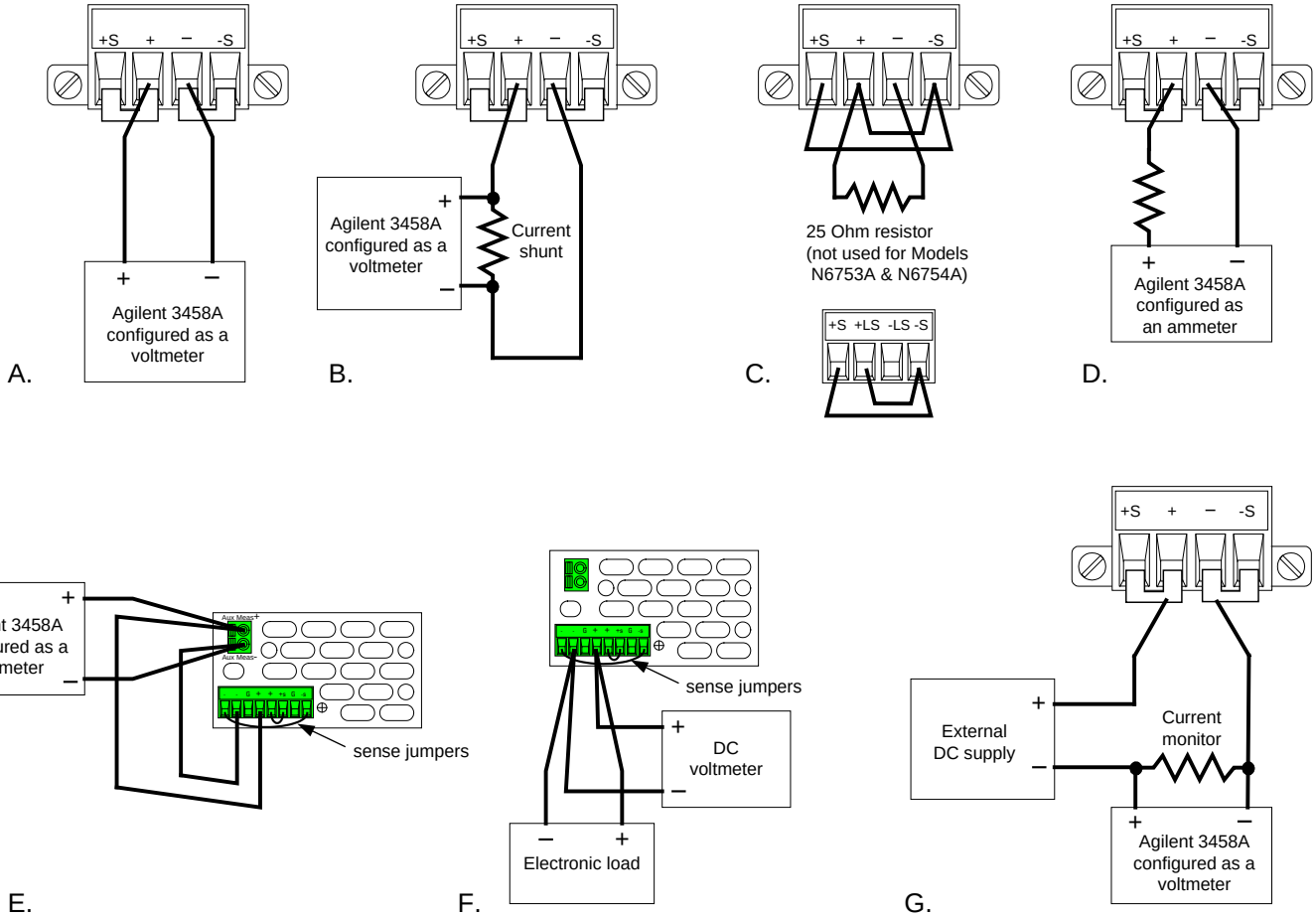
Calibration Switches

Two switches control the access to calibration commands. The switches are on the interface board and are accessible by removing the top cover. Refer to “Accessing the Calibration switch” in chapter 4. Switches 1 and 2 set the calibration configuration as follows:

	Sw 1	Sw 2	Description
Normal	ON	ON	This is the default or as-shipped switch setting. The calibration functions are accessible after entering a numeric password. The default password is 0 (zero).
Clear password	OFF	ON	The admin/calibration password is reset to 0 when the instrument is first powered on. Use this setting if you have forgotten the password.
Inhibit calibration	OFF	OFF	All calibration commands are disabled. This is useful where calibration access is guarded by instrument seals.

Calibration Set-up

The following figures show the calibration test set-ups. Connect all leads to the output terminals as shown in the following figure. Twist the + and - load leads to reduce noise and inductance.



NOTE Load lead lengths for models N678xA SMU must be between 1 and 4 feet.

Calibration Procedure – Models N673xB, N674xB, N677xA

Enter Calibration mode

Front Panel:	SCPI Command:
Select **System\Admin\Login**. Enter your password in the Password field and press Select.	`CAL:STAT ON, <password>`

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Agilent 3458A DMM to an output channel (see Cal Setup A).

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 60 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the High range.	`CAL:VOLT 60, (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Current Calibration

High Range Programming and Measurement

The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal setup B). Connect the Agilent 3458A DMM across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 5 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog** Then select the High range.	`CAL:CURR 5, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Enter a Calibration Date

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Date**. Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.	To enter a calibration date: `CAL:DATE "<date>", (@1)`

Save and Log out of Calibration Mode

CAUTION Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, do not Save the data when you exit the calibration mode. The calibration will then remain unchanged.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Save**. Select Save to save all calibration data.	To save calibration data: `CAL:SAVE`
Select **System\Admin\Logout** to exit calibration mode.	To exit calibration mode: `CAL:STAT OFF`

Calibration Procedure – Models N675xA

Enter Calibration mode

Front Panel:	SCPI Command:
Select **System\Admin\Login**. Enter your password in the Password field and press Select.	`CAL:STAT ON, <password>`

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Agilent 3458A DMM to an output channel (see Cal Setup A).

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 50 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the High range.	`CAL:VOLT 50, (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Voltage Common Mode Rejection Ratio Calibration

Step 1. For this step, make the connections shown in Cal Setup C. Connect an external jumper between the +sense and the –sense terminals. Connect a second jumper from the +output to the –sense terminal. For models N6751A and N6752A **only**, connect a 25 Ω load resistor across the +output and –output terminals.

This procedure is automatic and only takes a few seconds.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\CMRR**. Then select Next.	`CAL:VOLT:CMRR (@1)` `*OPC?`

After calibration completes, disconnect all jumpers and resistors.

Current Calibration

High Range Programming and Measurement

The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal Setup B). Connect the Agilent 3458A across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. This example selects the 5 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog** Then select the High range.	`CAL:CURR 5, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	CAL:DATA <data>

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	CAL:LEV P2 *OPC?

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:DATA <data>

Peak Current Limit Calibration

Note that for models N6753A through N6756A, the peak current limit calibration is valid for 5 years.

Step 1. Connect only the electronic load or equivalent resistor (up to 500W rating) across the output terminals for the first calibration point:

Model	1st calibration point	2nd calibration point
N6751A /N6752A:	25 Ω resistor (do not use electronic load)	4 Ω resistor (do not use electronic load)
N6753A:	Electronic load set to 26.25A, CC mode (0.6 Ω equivalent, including lead resistance)	Electronic load set to 13.12A, CC mode (1.2 Ω equivalent, including lead resistance)
N6754A:	Electronic load set to 10.5A, CC mode (3.8 Ω equivalent, including lead resistance)	Electronic load set to 5.25A, CC mode (7.6 Ω equivalent, including lead res.)
N6755A:	Electronic load set to 43.75A, CC mode (0.37 Ω equivalent, including lead resistance)	Electronic load set to 21.88A, CC mode (0.73Ω equivalent, including lead resistance)
N6756A:	Electronic load set to 17.5A, CC mode (2.3 Ω equivalent, including lead resistance)	Electronic load set to 8.75A, CC mode (8.75Ω equivalent, including lead resistance)

Step 2. Select peak current limit calibration.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\Ipeak**.	CAL:CURR:PEAK (@1)

Step 3 Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	CAL:LEV P1 *OPC?

Step 4. Set the electronic load or connect the appropriate resistor for the second calibration point.

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	CAL:LEV P2 *OPC?

Downprogrammer Calibration

Step 1. Remove all loads from the output. This procedure is automatic and takes a few seconds.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\Dprog**. Then select Next.	CAL:DPRog (@1) *OPC?

Enter a Calibration Date

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Date**. Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.	To enter a calibration date: CAL:DATE "<date>", (@1)

Save and Log out of Calibration Mode

CAUTION Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, do not Save the data when you exit the calibration mode. The calibration will then remain unchanged.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Save**. Select Save to save all calibration data.	To save calibration data: CAL:SAVE
Select **System\Admin\Logout** to exit calibration mode.	To exit calibration mode: CAL:STAT OFF

Calibration Procedure – Models N676xA

Warm-up Period for Models N6761A and N6762A

Models N6761A and N6762A require a 30-minute warm-up period in the reset (*RST) state before starting calibration.

Enter Calibration mode

Front Panel:	SCPI Command:
Select **System\Admin\Login**. Enter your password in the Password field and press Select.	`CAL:STAT ON, <password>`

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Agilent 3458A DMM to an output channel (see Cal Setup A).

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 50 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the High range.	`CAL:VOLT 50, (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Voltage Programming

Step 1. Select the low-voltage programming range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 5 V range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the Low1 range.	`CAL:VOLT 5, (@1)`

Step 2. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 3. Measure the output voltage with the DMM and enter the data. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 4. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 5. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Voltage Measurement

Step 1. Select the low-voltage measurement range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 5 V measurement range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vmeas**. Then select the Low1 range.	`CAL:VOLT:MEAS 5, (@1)`

Step 2. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 3. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 4. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 5. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Voltage Common Mode Rejection Ratio Calibration

Step 1. For this step, make the connections shown in Cal Setup C. Connect an external jumper between the +sense and –sense terminals. Connect a second jumper from the +output to the –sense terminal. For models N6761A and N6762A **only**, connect a 25 Ω load resistor across the +output and –output terminals.

This procedure is automatic and only takes a few seconds.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\CMRR**. Then select Next.	`CAL:VOLT:CMRR (@1)` `*OPC?`

After calibration completes, disconnect all jumpers and resistors.

Current Calibration

High Range Programming and Measurement

The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal Setup B). Connect the Agilent 3458A across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. This example selects the 3 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog** Then select the High range.	`CAL:CURR 3, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration	`CAL:DATA <data>`

Low Range Current Programming

Step 1. Connect only the current measurement terminals of the Agilent 3458A to the output terminals.

Step 2. Select the low-current programming range. The value to program a range must be the maximum current of the range. This example selects the 100 mA range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog**. Then select the Low1 range.	`CAL:CURR 0.1, (@1)`

Step 3. Select the first current calibration point. Wait a minimum of 5 minutes for the output current to stabilize.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point. Wait a minimum of 30 seconds for the output current to stabilize.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Current Measurement

Step 1. Connect only the current measurement terminals of the Agilent 3458A to the output terminals.

Step 2. Select the low-current measurement range. The value to program a range must be the maximum current of the range. This example selects the 100 mA range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Imeas** Then select the Low1 range.	`CAL:CURR:MEAS 0.1, (@1)`

Step 3. Select the first current calibration point. For models N6761A and N6762A **only**, wait a minimum of 5 minutes for the internal temperature to stabilize.

Front Panel:	SCPI Command:
Select Next. The ammeter should be connected. Wait 5 minutes for models N6761A and N6762A. Select Next. The information field should indicate:"Enter measured current"	`CAL:LEV P1`

Step 4. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>` `*OPC?`

Steps 5 and 6 only apply to models N6761A and N6762A.

Step 5. Disconnect the Agilent 3458A from the output terminals. Then select the second current calibration point.

Front Panel:	SCPI Command:
The second calibration point is automatically selected. "Disconnect Meter" should be displayed. Press Select when done.	`CAL:LEV P2`

Step 6. Wait a minimum of 5 minutes for the internal temperature to stabilize. Then select the third current calibration point.

Front Panel:	SCPI Command:
The third calibration point is automatically selected. "Wait 5 minutes, press Next" should be displayed. Wait 5 minutes and select Next.	`CAL:LEV P3` `*OPC?`

100 uA/200 uA Range Measurement - for Option 1UA or 2UA only

Step 1. Remove all loads from the output. Leave the sense terminals connected to the output terminals.

Step 2. Select either the 100 µA current measurement range or the 200 µA measurement range. Then wait 10 seconds.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Imeas** Then select the Low2 range.	`CAL:CURR:MEAS 0.0001, (@1)` `*OPC?` or `CAL:CURR:MEAS 0.0002, (@1)` `*OPC?`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
The first calibration point is automatically selected. "Waiting 10 seconds" should be displayed.	`CAL:LEV P1`

Step 4. Connect the Agilent 3458A and a 20 k Ω resistor to the output (see equipment list in chapter 2 and Cal Setup D).

Step 5. Measure the output current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>` `*OPC?`

Peak Current Limit

Note that for models N6763A through N6766A, the peak current limit calibration is valid for 5 years.

Step 1. Connect only the electronic load or equivalent resistor (up to 500W rating) across the output terminals for the first calibration point:

Model	1st calibration point	2nd calibration point
N6761A /N6762A:	25 Ω resistor (do not use electronic load)	4 Ω resistor (do not use electronic load)
N6763A:	Electronic load set to 26.25A, CC mode (0.6 Ω equivalent, including lead resistance)	Electronic load set to 13.12A, CC mode (1.2 Ω equivalent, including lead resistance)
N6764A:	Electronic load set to 10.5A, CC mode (3.8 Ω equivalent, including lead resistance)	Electronic load set to 5.25A, CC mode (7.6 Ω equivalent, including lead res.)
N6765A:	Electronic load set to 43.75A, CC mode (0.37 Ω equivalent, including lead resistance)	Electronic load set to 21.88A, CC mode (0.73Ω equivalent, including lead resistance)
N6766A:	Electronic load set to 17.5A, CC mode (2.3 Ω equivalent, including lead resistance)	Electronic load set to 8.75A, CC mode (8.75Ω equivalent, including lead resistance)

Step 2. Select peak current limit calibration.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\Ipeak**.	`CAL:CURR:PEAK (@1)`

Step 3 Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	CAL:LEV P1 *OPC?

Step 4. Set the electronic load or connect the appropriate resistor for the second calibration point.

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The calibration is automatic.	CAL:LEV P2 *OPC?

Downprogrammer Calibration

Step 1. Remove all loads from the output. This procedure is automatic and takes a few seconds.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\Dprog**. Then select Next.	CAL:DPRog (@1) *OPC?

Enter a Calibration Date

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Date**. Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.	To enter a calibration date: CAL:DATE "<date>", (@1)

Save and Log out of Calibration Mode

CAUTION Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, do not Save the data when you exit the calibration mode. The calibration will then remain unchanged.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Save**. Select Save to save all calibration data.	To save calibration data: CAL:SAVE
Select **System\Admin\Logout** to exit calibration mode.	To exit calibration mode: CAL:STAT OFF

Calibration Procedure – Models N678xA SMU

Enter Calibration mode

Front Panel:	SCPI Command:
Select **System\Admin\Login**. Enter your password in the Password field and press Select.	`CAL:STAT ON, <password>`

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Agilent 3458A to an output channel (see Cal Setup A).

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. This example selects the 20 V full-scale range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the High range.	`CAL:VOLT 20, (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Steps 7 and 8 only apply to model N6784A.

Step 7. Select the third voltage calibration point for the negative range.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P3 measured data"	`CAL:LEV P3` `*OPC?`

Step 8. Measure the output voltage with the DMM and enter the data. The value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Voltage Programming

Step 1. Select the low-voltage programming range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 6 V range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the Low1 range.	`CAL:VOLT 6, (@1)`

Step 2. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 3. Measure the output voltage with the DMM and enter the data. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 4. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 5. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Step 6 only applies to models N6781A and N6782A.

Step 6. Repeat steps 1 through 5 for the 600 mV range. This time, select the Low2 range.

Steps 7 through 9 only apply to model N6784A.

Step 7. Select the third voltage calibration point for the negative range.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P3 measured data"	`CAL:LEV P3` `*OPC?`

Step 8. Measure the output voltage with the DMM and enter the data. The value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Step 9. Repeat steps 1 through 5, 7 and 8 for the 600 mV range. This time, select the Low2 range.

Low Range Voltage Measurement

Step 1. Select the low-voltage measurement range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 1 V range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vmeas**. Then select the Low1 range.	`CAL:VOLT:MEAS 1, (@1)`

Step 2. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 3. Measure the output voltage with the DMM and enter the data. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 4. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 5. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration	`CAL:DATA <data>`

Step 6 only applies to models N6781A and N6782A.

Step 6. Repeat steps 1 through 5 for the 100 mV range. This time, select the Low2 range.

Steps 7 through 9 only apply to model N6784A.

Step 7. Select the third voltage calibration point for the negative range.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P3 measured data"	`CAL:LEV P3` `*OPC?`

Step 8. Measure the output voltage with the DMM and enter the data. The value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Step 9. Repeat steps 1 through 5, 7 and 8 for the 100 mV range. This time, select the Low2 range.

Positive Voltage Limit

Step 1. Select the positive voltage limit range. The value to program a range must be the maximum voltage of the range to be calibrated. This example selects the 20 V positive limit range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vlim** Then select the High range.	`CAL:VOLT:LIM:POS 20, (@1)`

Step 2. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: Enter "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 3. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 4. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 5. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Step 6. Repeat steps 1 through 5 for the 6 V positive limit range. This time, select the Low range.

Auxiliary Voltage Measurement - Model N6781A

Step 1. Connect the auxiliary input terminals to the output terminals of model N6781A. Also connect the voltage input of the Agilent 3458A to the output terminals of model N6781A (see Cal Setup E).

Step 2. Select the auxiliary voltage measurement input.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vmeas** Then select the Aux voltage range.	`CAL:VOLT:MEAS:AUX (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 7. Select the third voltage calibration point for the negative range.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P3 measured data"	`CAL:LEV P3` `*OPC?`

Step 8. Measure the output voltage with the DMM and enter the data. The value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration	`CAL:DATA <data>`

Current Calibration

High Range Programming and Measurement

Do not connect anything to the Sense terminals.

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's rated full-scale current (see Cal Setup B). Connect the Agilent 3458A across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. This example selects the 3 A full-scale range of output 1.

Note that this procedure calibrates both the 3 A and 1 A ranges.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog** Then select the High range.	`CAL:CURR 3, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point. Wait a minimum of 5 minutes for the internal temperature to stabilize.

Front Panel:	SCPI Command:
Select Next. "Wait 5 minutes, press Next" should be displayed. Wait 5 minutes and select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 7. Select the third voltage calibration point for the negative range.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P3 measured data"	`CAL:LEV P3` `*OPC?`

Step 8. Calculate the shunt current (I=V/R) and enter the data. The value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Current Programming

Step 1. Connect only the current measurement terminals of the Agilent 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the low-current programming range. The value to program a range must be the maximum current of the range. Models N6781A and N6782A have 300 mA range. Model N6784A has a 100 mA and a 10 mA range. This example selects the 300 mA programming range of output 1. For model N6784A, select the 100 mA programming range.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog** Then select the Low1 range.	`CAL:CURR 0.3, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the current with the Agilent 3458A and enter the value. This value may be positive or negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 7. Select the third current calibration point for the negative range.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P3 measured data"	`CAL:LEV P3` `*OPC?`

Step 8. Measure the current with the Agilent 3458A and enter the value. This value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Step 9. Repeat steps 1 through 8 for the 10 mA programming range of model N6784A. This time, select the Low2 range.

100 mA Measurement Range

Step 1. Connect only the current measurement terminals of the Agilent 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the 100 mA range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Imeas** Then select the Low1 range.	`CAL:CURR:MEAS 0.1, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the current with the Agilent 3458A and enter the value. This value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

1 mA Measurement Range

Step 1. Connect the Agilent 3458A in series with a 10 kΩ resistor to the output (see equipment list in chapter 2 and Cal Setup D).

Step 2. Select the 1 mA range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Imeas** Then select the Low2 range.	`CAL:CURR:MEAS 0.001, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the current with the Agilent 3458A and enter the value. This value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

10 µA Measurement Range

Step 1. Connect the Agilent 3458A in series with a 1 MΩ resistor to the output (see equipment list in chapter 2 and Cal Setup D). Set the Agilent 3458A to measure current using the 100 µA range (no autoranging). The remote command to do this is "DCI 100e-6".

Step 2. Select the 10 µA measurement range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Imeas** Then select the Low3 range.	`CAL:CURR:MEAS 0.00001, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the current with the Agilent 3458A and enter the value. This value should be negative.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Positive Current Limit

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's rated full-scale current (see Cal Setup B). Connect the Agilent 3458A across the shunt resistor.

Step 2. Select the 3 A positive limit range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Ilim**.	`CAL:CURR:LIM:POS 3, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point. Wait 5 minutes for the internal temperature to stabilize before continuing.

Front Panel:	SCPI Command:
Select Next. "Wait 5 minutes, press Next" should be displayed. Wait 5 minutes and select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Resistance Calibration

Step 1. Connect an electronic load directly to the N6781A output (see Cal Setup F). Set the load to constant current mode, current to 0.95A. Also connect the Agilent 3458A to the N6781A output terminals.

Step 2. Select the 20 V resistance range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Misc\Resistance**. Then select the High range.	`CAL:RES 20 (@1)` `*OPC?`

Step 3. Select the first resistance calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second resistance calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 7. Select the third resistance calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P2` `*OPC?`

Step 8. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Step 9. Repeat steps 1 through 8 for the 6 V resistance range. This time, select the Low range.

Enter a Calibration Date

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Date**. Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.	To enter a calibration date: `CAL:DATE "<date>", (@1)`

Save and Log out of Calibration Mode

CAUTION Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, do not Save the data when you exit the calibration mode. The calibration will then remain unchanged.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Save**. Select Save to save all calibration data.	To save calibration data: `CAL:SAVE`
Select **System\Admin\Logout** to exit calibration mode.	To exit calibration mode: `CAL:STAT OFF`

Calibration Procedure – Models N6783A-BDA and -MFG

Enter Calibration mode

Front Panel:	SCPI Command:
Select **System\Admin\Login**. Enter your password in the Password field and press Select.	`CAL:STAT ON, <password>`

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Agilent 3458A DMM to an output channel (see Cal Setup A).

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 6 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Volt\Vprog**. Then select the High range.	`CAL:VOLT 6, (@1)`

Step 3. Select the first voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second voltage calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Measure the output voltage with the DMM and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Current Calibration

High Range Programming and Measurement

The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal setup B). Connect the Agilent 3458A DMM across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 3 A full-scale range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Iprog** Then select the High range.	`CAL:CURR 3, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	`CAL:LEV P1` `*OPC?`

Step 4. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	`CAL:DATA <data>`

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	`CAL:LEV P2` `*OPC?`

Step 6. Calculate the shunt current (I=V/R) and enter the data.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>`

Low Range Current Measurement

Step 1. Connect only the current measurement terminals of the Agilent 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the low current measurement range. The value to program a range must be the maximum current of the range. This example selects the 0.15 A range of output 1.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Imeas** Then select the Low1 range.	`CAL:CURR:MEAS 0.15, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The ammeter should be connected. Select Next. The information field should indicate: "Enter measured current"	`CAL:LEV P1` `*OPC?`

Step 4. Measure the current with the Agilent 3458A and enter the value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	`CAL:DATA <data>` `*OPC?`

Negative Current Limit Calibration

Step 1. Connect the Agilent 3458A, current shunt, and a power supply to the output (See Cal Setup G). Connect plus to plus, minus to minus. Set the external power supply to 3V, 3A.

Step 2. Select the negative-current range. The value to select the range must be negative and the maximum current of the range.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Curr\Ilim**.	`CAL:CURR:LIM:NEG -2, (@1)`

Step 3. Select the first current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P1 measured data"	CAL:LEV P1 *OPC?

Step 4. Calculate the shunt current (I=V/R); enter the *negative* current value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done.	CAL:DATA <data>

Step 5. Select the second current calibration point.

Front Panel:	SCPI Command:
Select Next. The information field should indicate: "Enter P2 measured data"	CAL:LEV P2 *OPC?

Step 6. Calculate the shunt current (I=V/R); enter the *negative* current value.

Front Panel:	SCPI Command:
Select the Measured Data field. Enter the data from the external DMM. Press Select when done. Select Next to finish calibration.	CAL:DATA <data>

Enter a Calibration Date

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Date**. Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.	To enter a calibration date: CAL:DATE "<date>", (@1)

Save and Log out of Calibration Mode

CAUTION Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, do not Save the data when you exit the calibration mode. The calibration will then remain unchanged.

Front Panel:	SCPI Command:
Select **System\Admin\Cal\Save**. Select Save to save all calibration data.	To save calibration data: CAL:SAVE
Select **System\Admin\Logout** to exit calibration mode.	To exit calibration mode: CAL:STAT OFF

Change the Admin/Calibration Password

The password must be numeric, and can be up to 15 digits in length. After it has been changed, you can only enter the calibration mode by providing the correct password.

If the password is lost or forgotten, access can be restored by setting an internal switch that resets the password to zero (refer to "Accessing the Calibration switch" in chapter 4). Once you have set the password to zero with the switch, you can enter a new password using the Admin menu or using the CAL:PASS command. The new password will become active when you log out of the Admin Menu or send CAL STAT OFF. After you have returned the switches to the normal position, you can access the Admin menu with the new password.

Front Panel:	SCPI Command:

Select **System\Admin\Login**.
Enter the original password in the Password field and press Select.
Select **System\Admin\Password**.
Enter a new password in the Password field.
Logout of the Admin menu to activate the password.
	Enter calibration mode using the original password
	`CAL:STAT ON, <password>`
	To change the password:
	`CAL:PASS <NRf>`
	To exit calibration mode and activate the password:
	`CAL:STAT OFF`

NOTE If the message "Locked out by internal switch setting" or "Calibration is inhibited by switch setting" appears, the internal switch is set to prevent the password from being changed (refer to "Accessing the Calibration switch" in chapter 4).

4
Disassembly

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This chapter discusses the disassembly procedures for troubleshooting and repairing Agilent N6700B, N6701A, and N6702A MPS mainframes.

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 volts. The following guidelines will help prevent ESD damage when servicing the instrument or any electronic device.

- Disassemble instruments *only* in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.

Disassembly Procedures

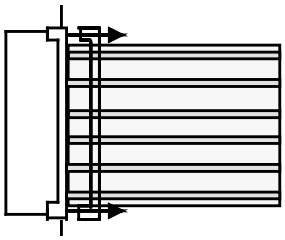
WARNING **SHOCK HAZARD. FAN HAZARD. Turn off the mainframe and disconnect its power cord before attempting any of the following procedures.**

Required Disassembly Tools

Tool	Use
9/32 Hex driver	Removing GPIB connector
5/16 Hex driver	Removing DC cable assembly from bias supply
T20 Torx driver	Removing bias board, handles, and bulk supply
T10 Torx driver	Removing covers and board assemblies

Ribbon Cables

- Note the position of the conductive side of the cable for re-installation. (The blue tab is on the non-conductive side.)
- Release the ribbon cable by pulling up on the locking tab as shown by the arrows in the following figure.



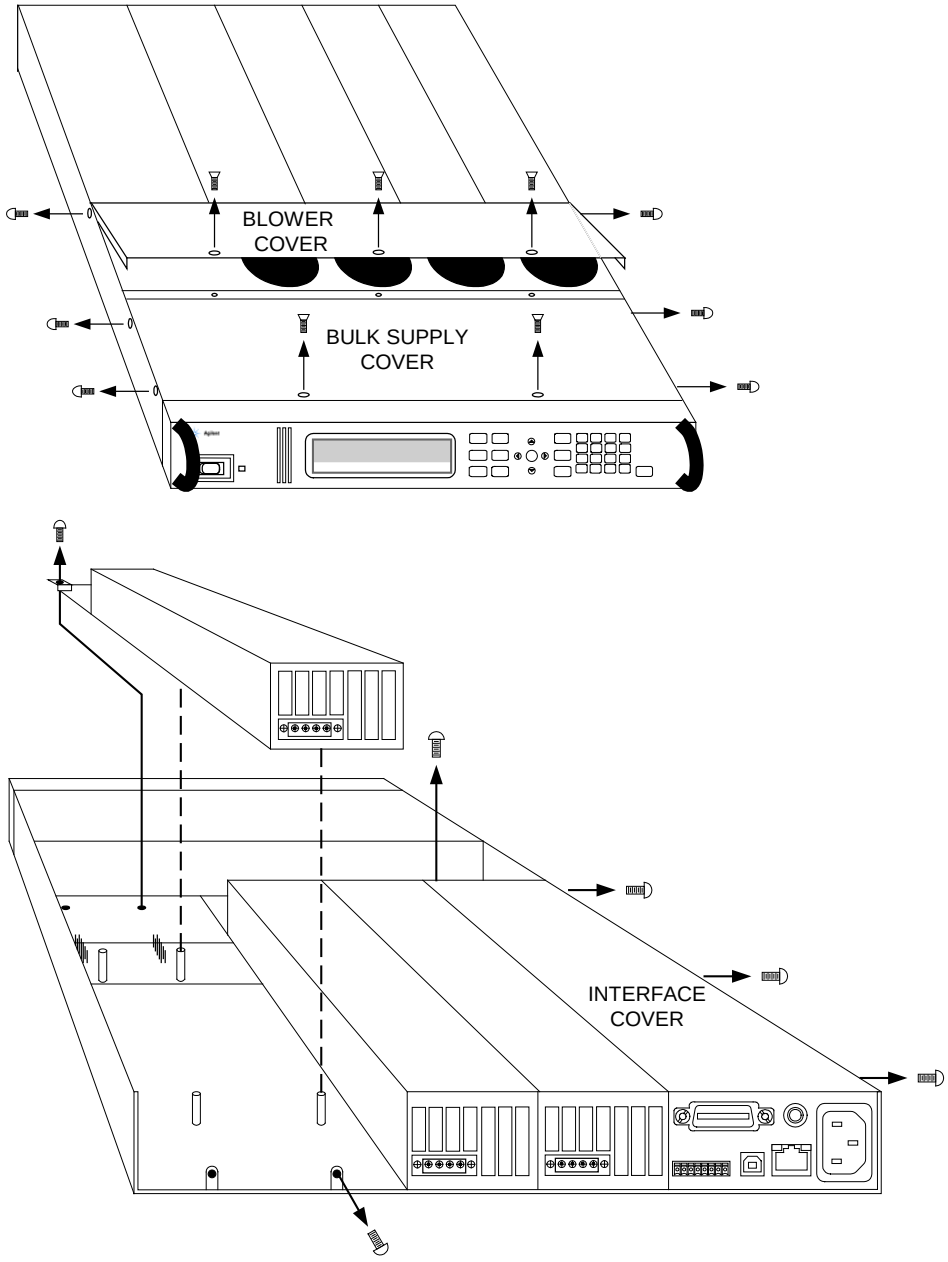
- To replace the cable, fully insert the cable into the connector; then push down on the locking tab to secure the cable.

Removing/Installing Modules

CAUTION Modules must be installed next to one another, starting with slot 1. Do not leave any empty slots *between* modules, otherwise the power system will not operate. Any remaining unused slots must have a filler module installed to ensure proper cooling. Do not install filler modules *between* power modules.

Step 1. Remove the blower cover. Remove three screws from the top of the cover and two screws on the sides. Tilt the cover up and slide it out.

Step 2. To remove a module, first remove the two fastening screws at either end of the module. Grasp the module at the ends (near the fan and the output connector), and lift it straight up out of the mainframe.



Step 3. To install a module, align the module over the alignment pins, and push it down onto the mainframe connector.

Step 4. Fasten the module to the mainframe. Install the two screws from the power module or filler module at either end of the module. Because the RFI strips are applying upward pressure, continue pushing down on the module until the screws are fully tightened.

Step 5. Replace the blower cover when finished.

Accessing the Calibration switch

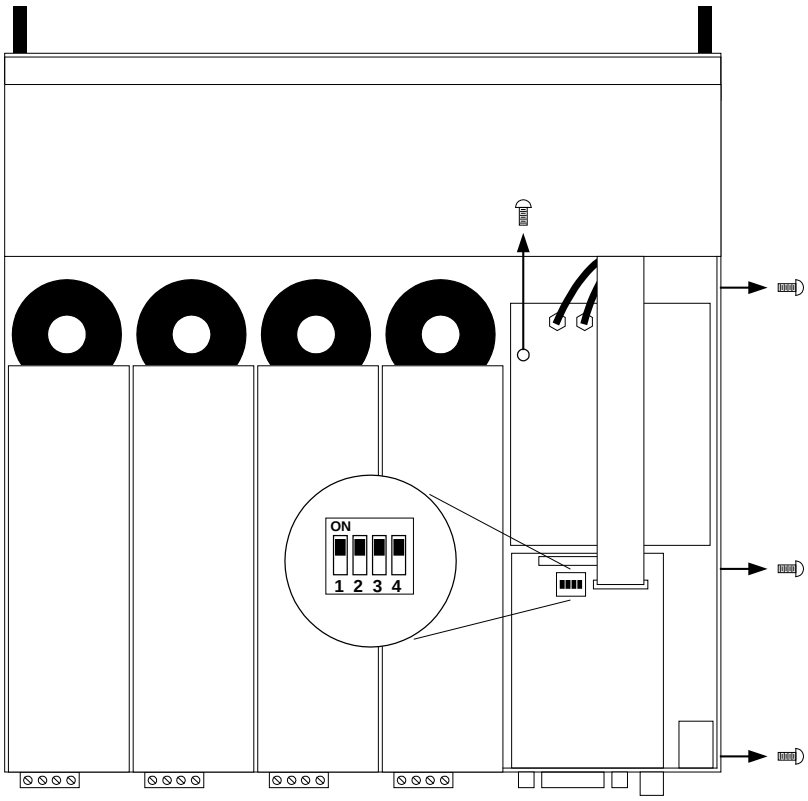
Step 1. Remove the blower cover. Remove three screws from the top of the cover and two screws on the sides. Tilt the cover up and slide it out.

Step 2. Remove the interface cover. Remove the three screws along the left side of the unit. Then remove the screw at the front of the cover. Lift off the cover.

Step 3. The calibration switch is on the interface board near the ribbon cable. To change the calibration switch settings, use a small screwdriver to move the switches. Refer to chapter 3 for settings information.

CAUTION Do not use a pencil to move the switches. Any graphite dust that gets on the switches will conduct electricity.

Step 4. Replace all covers when finished.



Removing/Installing the Interface (PPMC) board

Step 1. Remove the blower cover. Remove three screws from the top of the cover and two screws on the sides. Tilt the cover up and slide it out.

Step 2. Remove the interface cover. Remove the three screws along the left side of the unit. Then remove the screw at the front of the cover. Lift off the cover.

Step 3. Use a hex wrench to remove the GPIB connector from the rear of the mainframe Disconnect all cable assemblies from the interface board.

Step 4. Disconnect the 3 cable assemblies located along the front edge of the board. Use a T10 driver and remove the screws that attach the board to the chassis. Lift the board out.

Step 5. To reinstall the interface board, perform the above steps in reverse order. Replace all covers when finished.

Removing/Installing the Bias board

Step 1. Remove the blower and interface covers as previously described.

Step 2. Disconnect all cable assemblies from the bias board.

Step 3. Use a T10 driver and remove the screws that attach the bias board to the chassis. Use a T20 driver and remove the 4 screws that attach the board to the backplane assembly. Lift the board out.

Step 4. To reinstall the bias board, perform the above steps in reverse order. Replace all covers when finished.

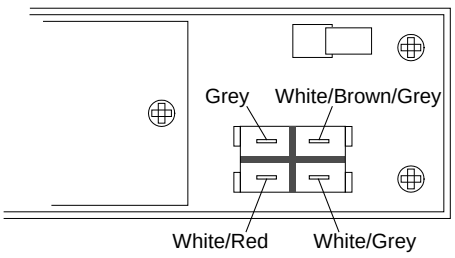
Removing/Installing the Front Panel Assembly

Step 1. Remove the two screws along the front of the bulk supply cover as well as the four screws on each side of the front panel assembly that attach the front panel assembly to the chassis.

Step 2. Slide the front panel assembly forward and away from the chassis to access the test points for troubleshooting.

Step 3. To completely remove the front panel assembly, disconnect the ribbon cable between the front panel board and the interface board at the front panel board.

Step 4. Disconnect the wires going to the S1 switch assembly. For reassembly, make a note of the color coding of the wires and the pins to which they are connected.



Step 5. To remove the front panel board, remove the six screws that secure the board to the front frame assembly.

Step 6. To remove the display module, first disconnect the cable at the P1 connector and the ribbon cable at the J2 connector. Then untwist the tabs that hold the display module to the front panel board.

Step 7. To reinstall the front panel assembly, perform the above steps in reverse order.

Removing/Installing the Bulk Supply

Step 1. Remove the blower cover, bulk supply cover, and interface cover as previously described.

Step 2. Remove the power module from slot #3 in the mainframe. You now have access to two of the screws that install the bulk supply.

Step 3. Remove the four screws on each side of the front panel assembly that attach the front panel assembly to the chassis. Slide the front panel assembly forward and away from the chassis. You now have access to the remaining screws that install the bulk supply.

Step 4. Use a T20 driver and remove all screws that fasten the bulk supply to the chassis.

Step 5. **For N6700B and N6701A mainframes**, slide the bulk supply over so that you can access the AC and DC cable assembly connectors.
For N6702A mainframes, which have two paralleled bulk supplies, disconnect the ribbon cable that connects the interface board to the front panel by gently lifting up on the interface board connector. Slide the ribbon cable out so that you can access the AC and DC cable assembly connectors.

Step 6 Disconnect the DC and AC cable assemblies and lift the bulk supply out of the unit. For reassembly, make a note of the color-coding of the wires and the pins to which they are connected.

Cable assembly	Connected to Pin
Red (DC)	+48 V
Black (DC)	–48 V
Grey (AC)	AC
Red/white (AC)	ACC
Green/yellow (AC)	ground

Step 7. To reinstall the bulk supply, perform the above steps in reverse.

Installing a Redundant Ground for 400 Hz Operation

Operation at 400 Hz requires the installation of a redundant ground from the instrument chassis to earth ground. The redundant ground must be permanently attached to the unit as well as to the earth ground point.

The following procedure only describes how to make the permanent connection at the unit. The user must ensure the integrity and permanence of the connection at the earth ground point.

The following customer-supplied hardware is required:

- Ground wire (14/16 AWG)
- Uninsulated ring terminal for attaching wire to unit (Tyco p/n 34124 or equivalent)
- Hardware for attaching wire to earth ground point

The following tools are required for installing the redundant ground:

- 3/8 inch hex wrench

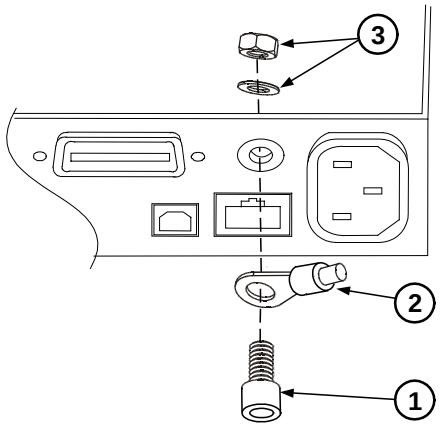
Step 1. Remove the top cover of the GPIB board as previously described under “Accessing the Calibration switch”.

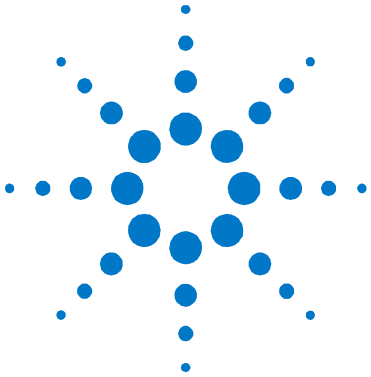
Step 2. Use the wrench and remove the binding post (1) from the rear of the chassis. The binding post is located between the AC input connector and the GPIB connector.

Step 3. Crimp the appropriate ring terminal (2) onto the end of the ground wire.

Step 4. Place the ring terminal onto the threaded end of the binding post. Re-install the binding post on the chassis with the washer and nut (3).

Step 5. Rotate the ring terminal so that the ground wire does not interfere with any other connectors on the back of the unit. Use the wrench and tighten the binding post to the chassis (Torque = 20 – 25 in-lb.).





5 Troubleshooting

Preliminary Checkout 90
Overall Troubleshooting 91
Front Panel Troubleshooting 94
Bias Board Troubleshooting 94
Backplane Board Troubleshooting 95
Calibration and Passwords 96
Initialization 96

Before performing the Overall Troubleshooting procedures, perform the Preliminary Checkout procedure in the beginning of this chapter.

If the power system passes selftest and there are no obvious faults, perform the verification procedures in chapter 2 to determine if any power modules are not calibrated, or are not operating properly. This will help isolate a problem to a specific power module.

The following table documents the test equipment required for troubleshooting Agilent N6700 MPS mainframes.

Model	Description
Agilent 34401A or equivalent	Digital multimeter (for measuring voltage and resistance)

Preliminary Checkout

Is the instrument inoperative?

- Verify that the AC power cord is connected to the instrument.
- Verify that the front-panel On/Standby switch has been pushed.

Is the display working?

- If the display is hard to read, but front-panel LED is lit and the fans are working, the display contrast setting may be too light or too dark. Use the front panel menu to set the display contrast.

Does the instrument fail selftest?

- Remove all external connections to the instrument.
- Check that modules are installed next to each other, starting with slot 1. If there are any empty slots (or filler modules) *between* the power modules, the power system will not operate.
- Check that the mainframe has the latest firmware installed.
- Turn off the unit and cycle power to run selftest again.

If the supply passes selftest and there are no obvious faults, perform the verification procedures in chapter 2 to determine if any functions are not calibrated, or are not operating properly.

Self-test Error List

The following table documents the self-test error messages. Refer to Appendix A for other error messages.

	Selftest Errors (these errors set Standard Event Status register bit #3)
202	**Selftest Fail Aux Adc 0 expected <n1> to <n2>, measured <n3>, chan <n4>** Auxiliary ADC failed. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 0 expected <n1> to <n2>, measured <n3>, chan <n4>** Both voltage and current DACs are at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 1 expected <n1> to <n2>, measured <n3>, chan <n4>** Voltage DAC is at zero; current DAC is at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 2 expected <n1> to <n2>, measured <n3>, chan <n4>** Voltage DAC is at full scale; current DAC is at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 3 expected <n1> to <n2>, measured <n3>, chan <n4>** Both voltage and current DACs are at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

Overall Troubleshooting

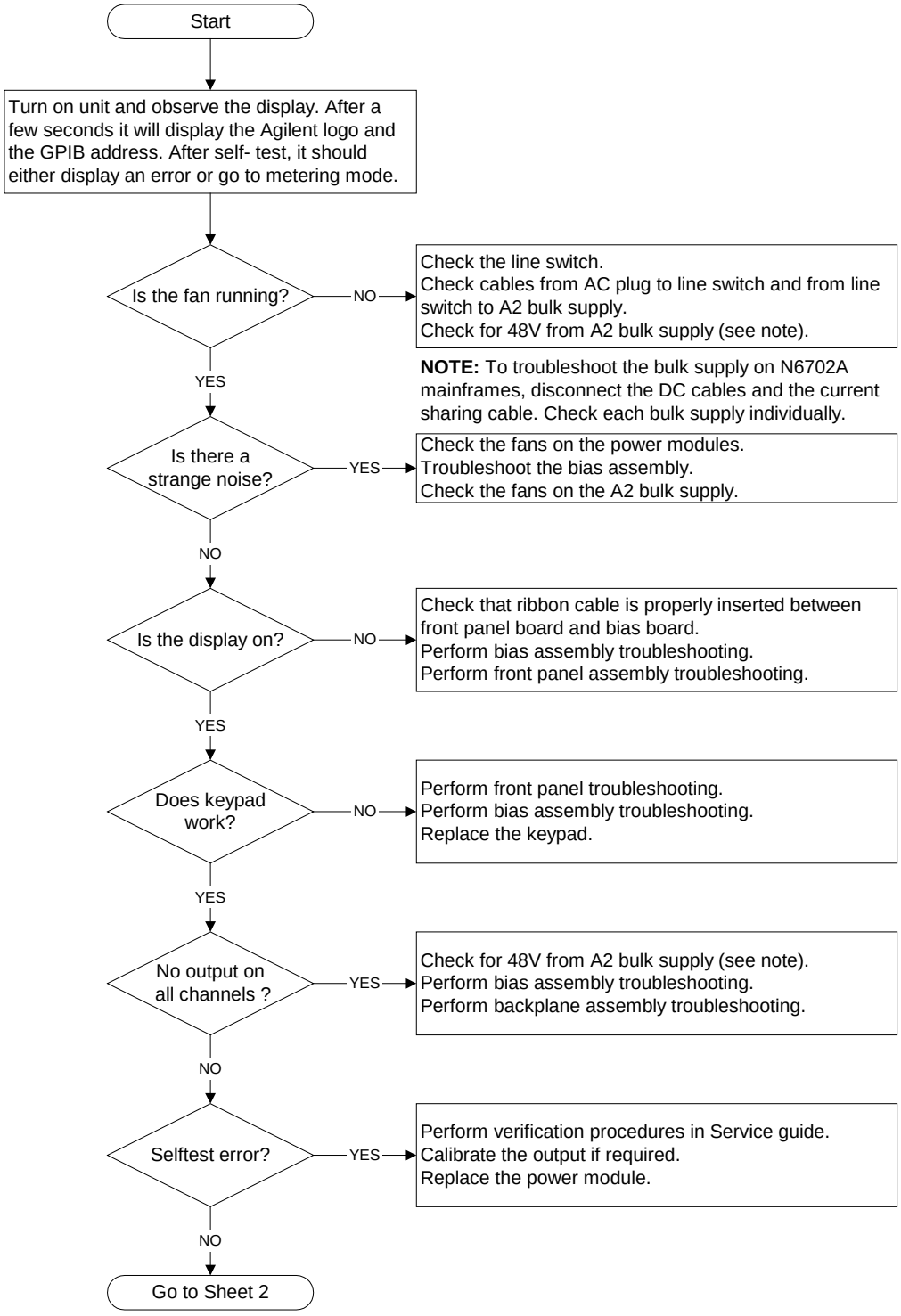

Start
Turn on unit and observe the display. After a few seconds it will display the Agilent logo and the GPIB address. After self- test, it should either display an error or go to metering mode.
Is the fan running?
NO
Check the line switch.
Check cables from AC plug to line switch and from line switch to A2 bulk supply.
Check for 48V from A2 bulk supply (see note).
YES
NOTE: To troubleshoot the bulk supply on N6702A mainframes, disconnect the DC cables and the current sharing cable. Check each bulk supply individually.
Is there a strange noise?
YES
Check the fans on the power modules.
Troubleshoot the bias assembly.
Check the fans on the A2 bulk supply.
NO
Is the display on?
NO
Check that ribbon cable is properly inserted between front panel board and bias board.
Perform bias assembly troubleshooting.
Perform front panel assembly troubleshooting.
YES
Does keypad work?
NO
Perform front panel troubleshooting.
Perform bias assembly troubleshooting.
Replace the keypad.
YES
No output on all channels ?
YES
Check for 48V from A2 bulk supply (see note).
Perform bias assembly troubleshooting.
Perform backplane assembly troubleshooting.
NO
Selftest error?
YES
Perform verification procedures in Service guide.
Calibrate the output if required.
Replace the power module.
NO
Go to Sheet 2

Figure 3-1. Overall Troubleshooting Sheet 1

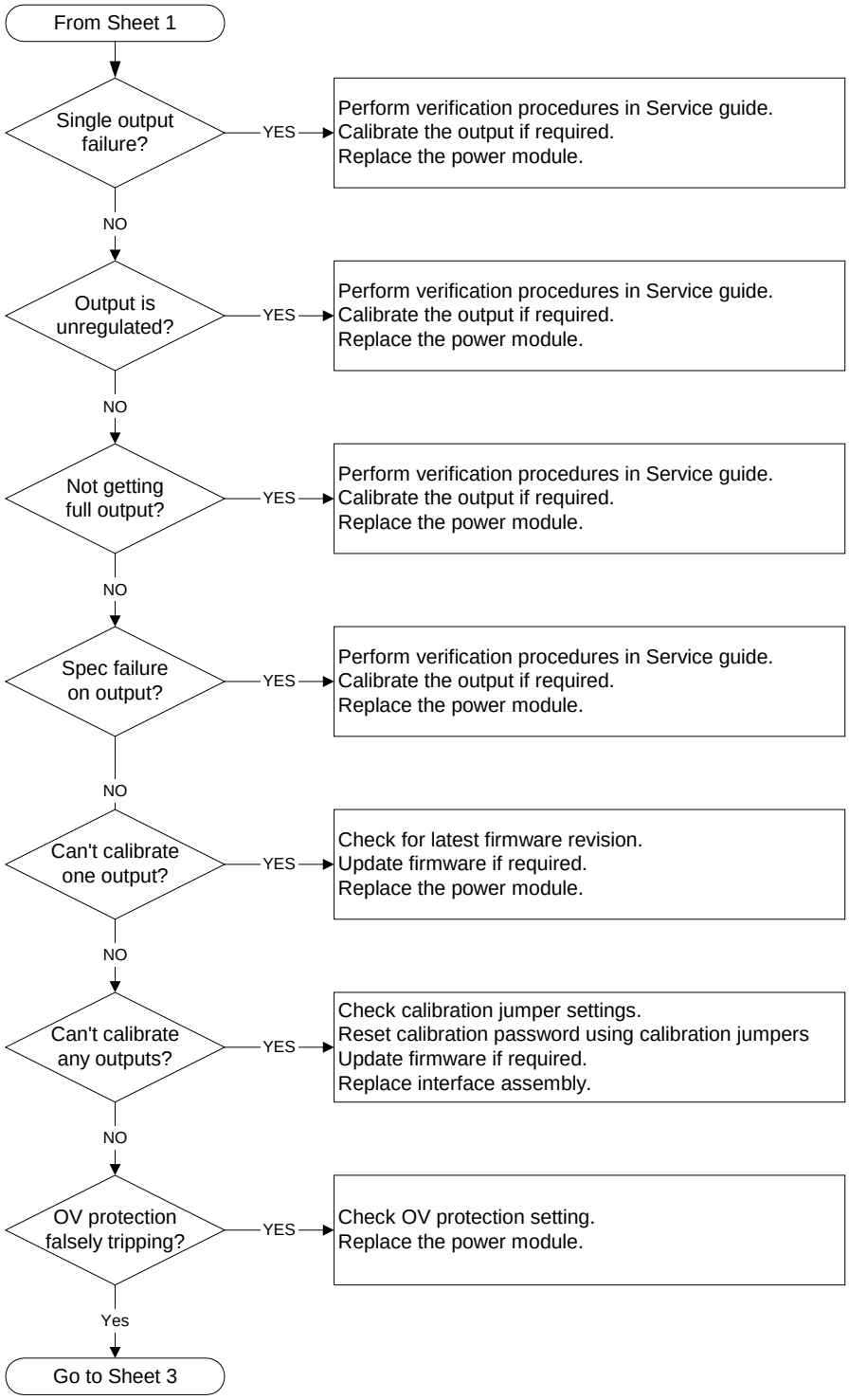


Figure 3-1. Overall Troubleshooting Sheet 2

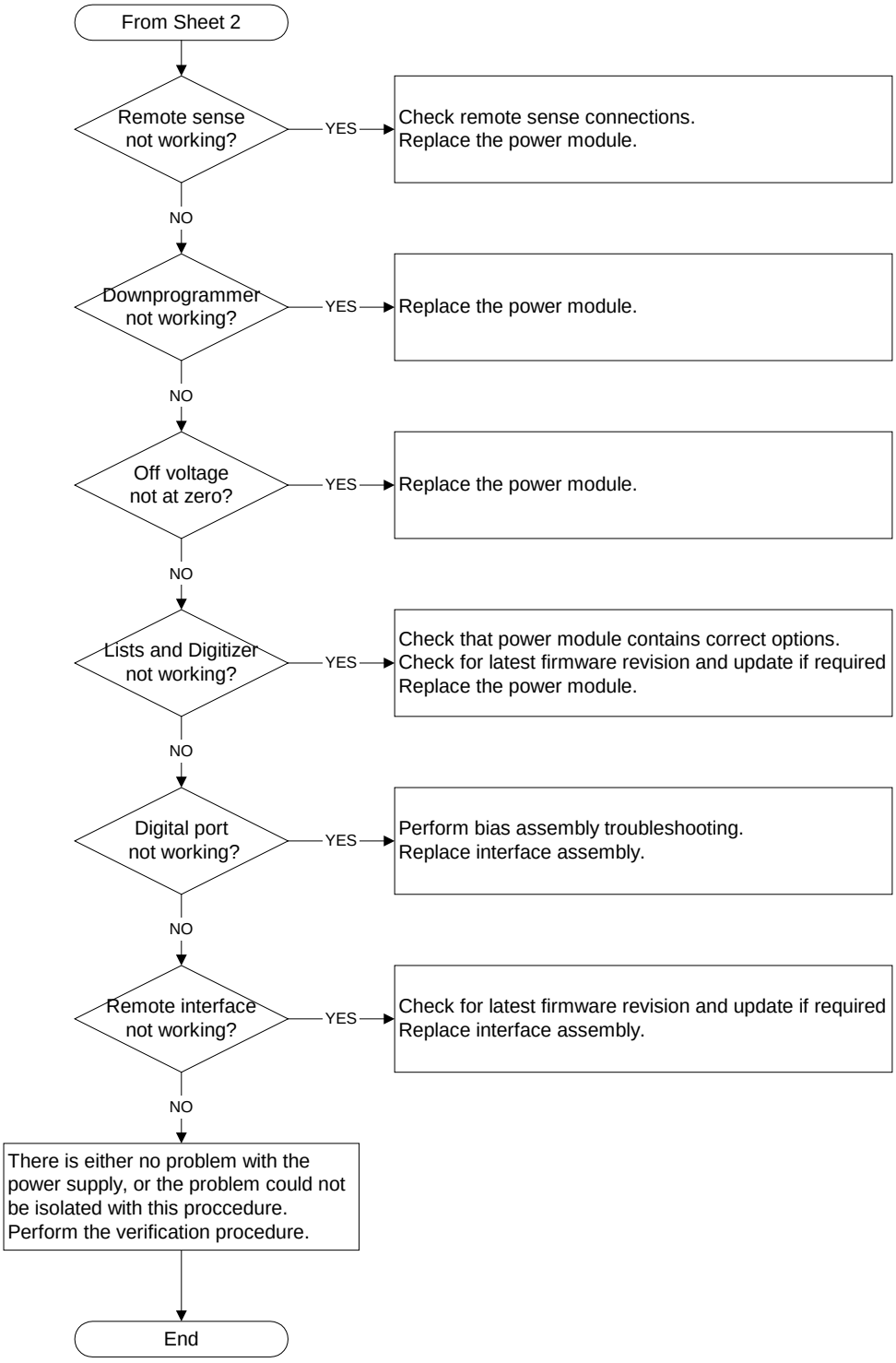
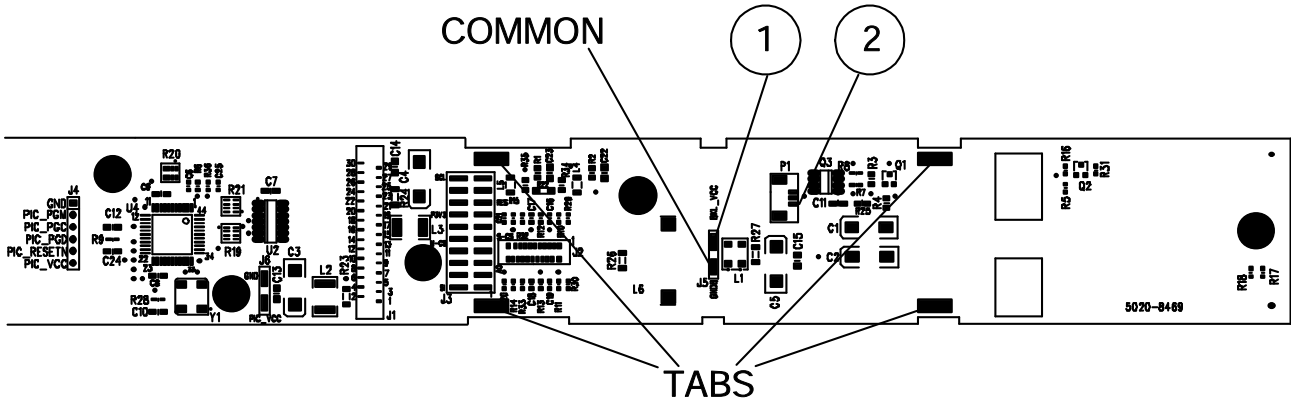


Figure 3-1. Overall Troubleshooting Sheet 3

Front Panel Troubleshooting

Troubleshooting the front panel board involves checking for the presence of the correct bias voltages on the board. Refer to the following table and figure.

Test Point	Location	Voltage	Action
TP 1	BKL_VCC	+12 V	If bias not present, troubleshoot the bias board or replace the front panel board.
TP 2	P1 pin 3	+12 V	If backlight voltage not present, replace the front panel board. If voltage is present and the display is not lit, replace the display.
Common	GNDB	Common	

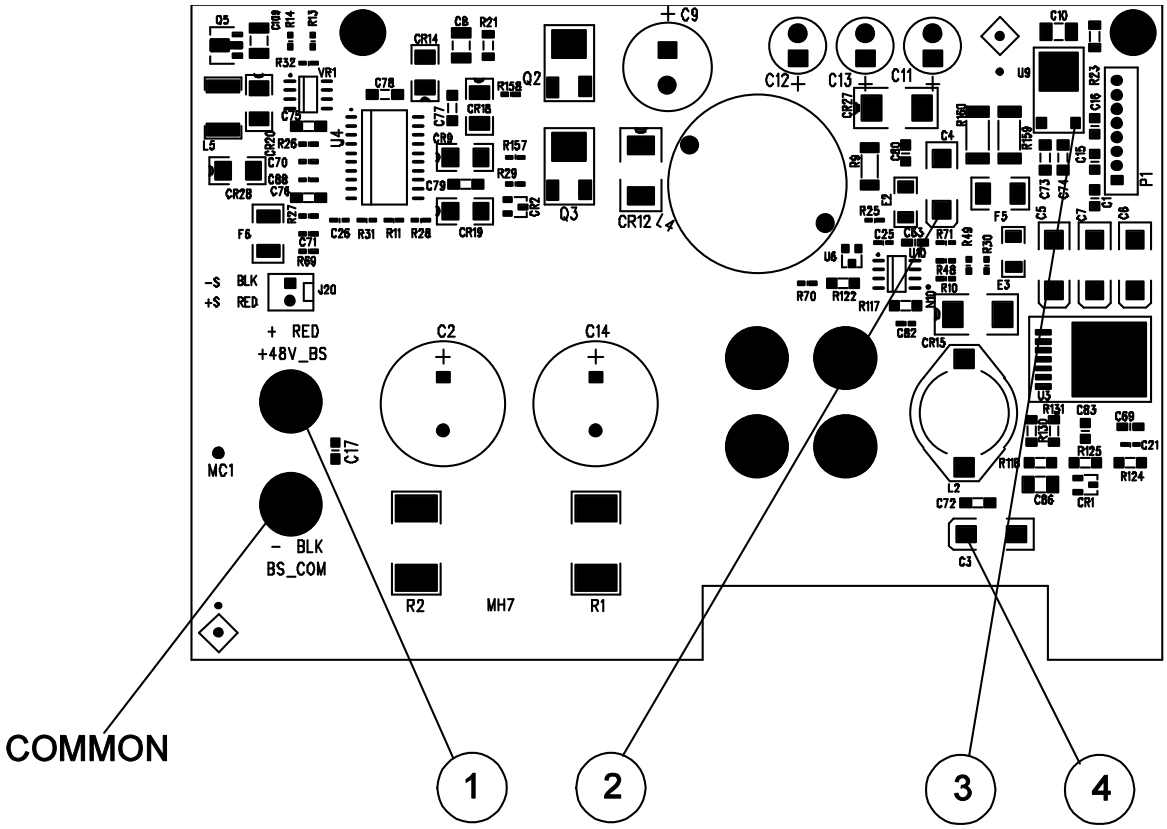


Bias Board Troubleshooting

Troubleshooting the bias board involves checking for the presence of the correct bias voltages on the board. Refer to the following table and figures.

Note that if the bias voltages at test points 2 - 4 in the following table are not present, it could be caused by a defect in the power module or interface board that is pulling the bias voltage low.

Test Point	Location	Voltage	Action
TP 1	+ RED	+48 V	Output of bulk supply. If not present, replace the bulk supply.
TP 2	+ C4	+12 V	If biases at TP 2, TP 3, or TP 4 are not present, disconnect the backplane and interface board cable assemblies and recheck. If biases are still not present, replace the bias board.
TP 3	U9 - 2	+5 V	Same as above.
TP 4	+ C3	+3.3 V	Same as above.
Common	– BLK	Common	



Backplane Board Troubleshooting

Troubleshooting the backplane board consists of visually inspecting the pins and pin connections.

If there are missing or broken pins, replace the board.

If there are bent pins, carefully try to straighten the pin. If you are unsuccessful, replace the board.

Closely examine the solder connections at the pins. If there are cracks in the solder, carefully re-solder the connector. If unsuccessful, replace the board.

Calibration and Passwords

Calibration is not required after the mainframe has been repaired. All calibration information is module-specific and resides in each power module.

However, if the A5 board that contains the calibration switches has been replaced, any calibration password that has been set will be lost. Passwords that are used to prevent access to the front panel Admin menu will also be lost.

The calibration password will automatically be reset to the factory default, which is zero (0). Front panel access to the Admin menu will be unrestricted unless a password is set.

Refer to the User's Guide for information on setting the calibration password as well as the Admin menu password.

Initialization

The power system's model number, serial number, and other constants that are required to program the instrument are stored in an EEPROM on the A5 board. If this board is replaced, the instrument must be re-initialized.

To initialize the power system, you must send the following information to the power system over the interface:

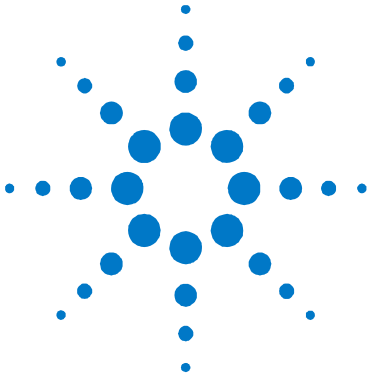
```
DIAGnostic:FRAMe:ATTRibute "ModelNumber", "value"
```

where "value" is the model number, e.g. N6700B.

```
DIAGnostic:FRAMe:ATTRibute "SerialNumber", "value"
```

where "value" is the serial number located on top of the interface cover.

At power-up, the power system will go through the turn-on self test sequence. All other parameters will be set to the factory defaults. The mainframe is now initialized.



6
Replaceable Parts

Parts List 98
Parts Location Diagrams 99

The following table documents the replaceable parts assembles. The diagrams show the location of the parts

Parts List

Reference Designator	N6700B Part number	N6701A Part number	N6702A Part number	Description
		Electrical Assemblies		
A1	N6700-61001	N6700-61001	N6700-61001	A1 Front Panel PCA (tested)
A2	0950-4655	0950-4687	0950-4687 (qty. 2)	A2 Bulk Supply
A3	5065-6981	5065-6981	5065-6981	A3 Backplane PCA
A4	N6700-60101	N6700-60101	N6700-60101	A4 Bias PCA (tested)
A5	N6700-60102	N6700-60102	N6700-60102	A5 Interface PCA (tested)
		Individual Parts		
1	5002-2817	5002-2817	5002-2828	Chassis frame
2	5002-2808	5002-2808	5002-2808	Front frame
3	1390-1079	1390-1079	1390-1079	Handles
4	N6700-40001	N6700-40001	N6700-40001	Keypad
5	2090-0886	2090-0886	2090-0886	Display
6	4040-2556	4040-2556	4040-2556	Window
7	N6700-00001	N6700-00001	N6700-00001	Front panel
8	3101-4019	3101-4019	3101-4019	Line switch
9	5185-1358	5185-1358	5185-1358 (qty. 2)	Cable, bulk supply to ground
10	5185-1357	5185-1357	5188-4205	AC cable, bulk supply to switch
11	5185-1362	5185-1362	5185-1362	DC power cable
12	5185-1354	5185-1354	5185-1354	Ribbon cable, to front panel
13	5185-1382	5185-1382	5185-1382	Ribbon cable, to backplane
14	5185-1352	5185-1352	5185-1352	Insulator, under backplane
15	5185-1384	5188-4210	5188-4210	Bias cable assembly
16	5185-1397	5185-1397	5185-1397	AC cable with socket
17	1510-0038	1510-0038	1510-0038	Binding post
18	E5810-61605	E5810-61605	E5810-61605	GPIB connector with cable
19	1253-6408	1253-6408	1253-6408	Digital plug
20	N.A.	5002-2830	N.A.	Bulk supply bracket
21	N.A.	N.A.	5188-4207	Current share cable
22	N.A.	N.A.	5188-4206	DC power cable for 2nd bulk supply
		Covers and Labels		
	5002-2809	5002-2809	5002-2829	Bulk supply cover
	5002-2810	5002-2810	5002-2810	Blower cover
	5002-2807	5002-2807	5002-2807	Interface cover
	N6700-80006	N6701-80006	N6702-80006	Front/Rear/Interface labels
	5185-1387	5185-1387	5185-1387	Blower cover label (caution)

Parts Location Diagrams

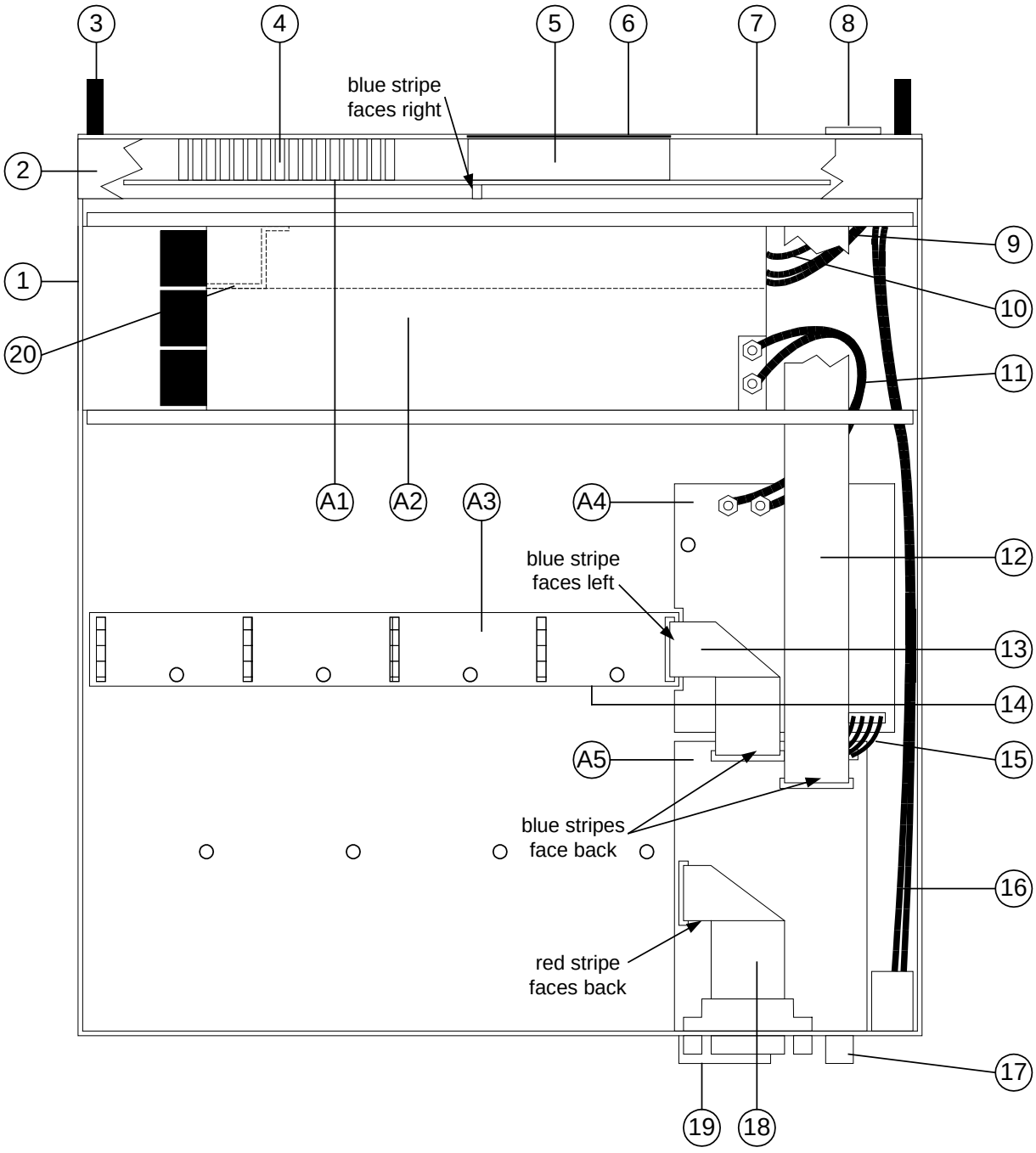


Figure 4-1. N6700B/N6701A Mainframe Part Locations

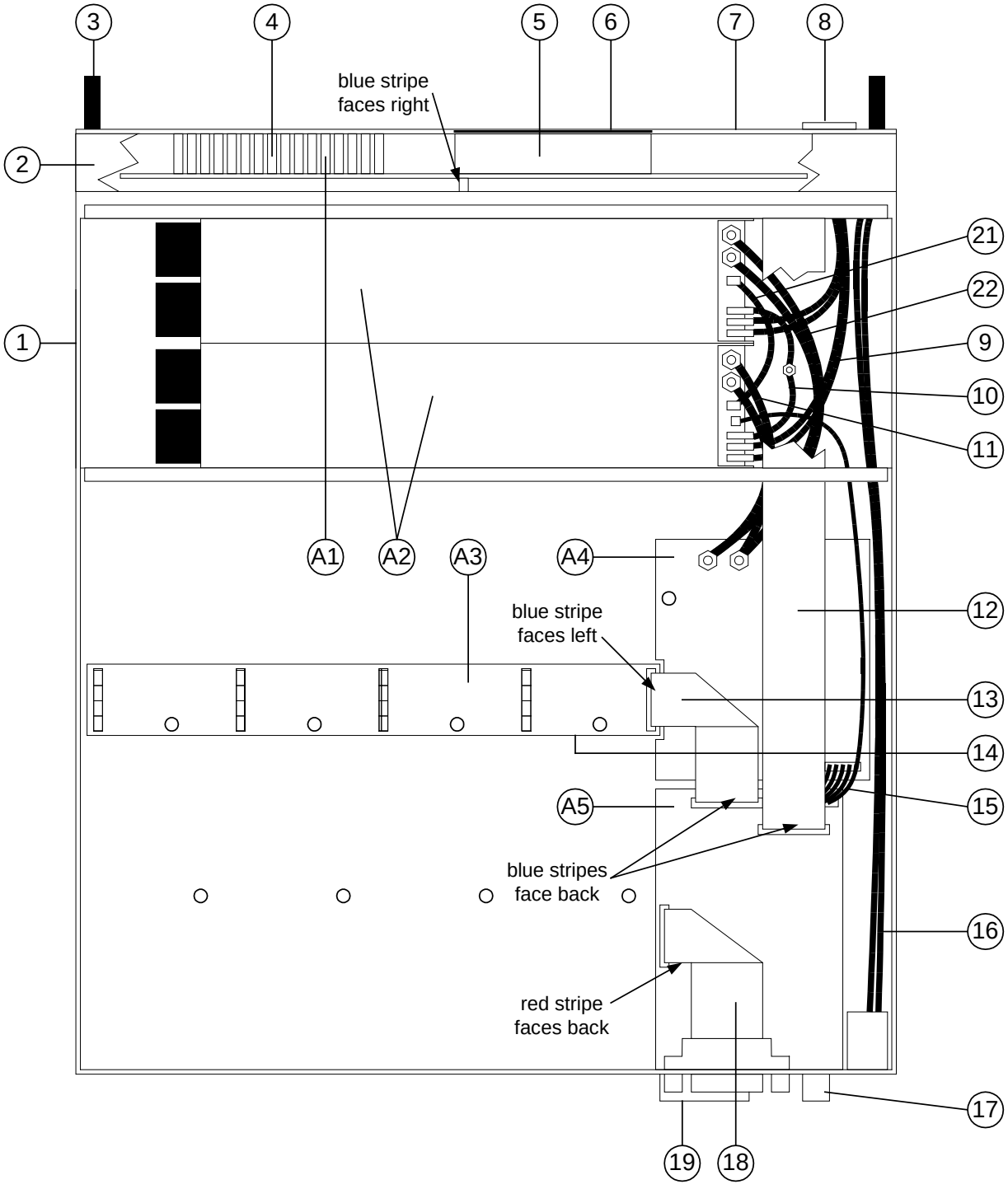
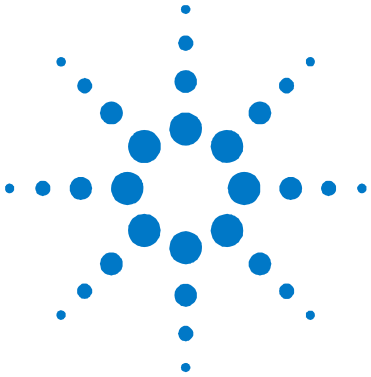


Figure 4-2. N6702A Mainframe Part Locations



Appendix A
Error Messages

Displaying Error Messages 102
Error List 102

This appendix gives the error numbers and descriptions that are returned by the Agilent N6700 Modular Power System.

Error messages can be displayed on the front panel and also read back programmatically.

Displaying Error Messages

The instrument beeps each time a command syntax or hardware error is generated. The front-panel **ERR** annunciator turns on when one or more errors are currently stored in the SCPI error queue.

Front Panel:	SCPI Command:
Press the Error key. If errors appear, use the navigation keys to scroll though the list.	SYST:ERR?

Errors are cleared as they are read. When all errors have been read, the **ERR** annunciator turns off and the error queue is cleared.

Error List

Error	**Device-dependent Errors** (these errors set Standard Event Status register bit #3)
0	**No error** This is the response to the ERR? query when there are no errors.
100	**Too many channels** You have specified more channels than are installed in the mainframe.
101	**Calibration state is off** Calibration is not enabled. The instrument will not accept calibration commands.
102	**Calibration password is incorrect** The calibration password is incorrect.
103	**Calibration is inhibited by switch setting** Calibration mode is locked out by the calibration switch.
104	**Bad sequence of calibration commands** Calibration commands have not been entered in the proper sequence.
105	**Unexpected output current** The measured output current is outside the acceptable range.
106	**Zero measurement out of range error** The “zero” measurement value is outside the acceptable range.
107	**Programming cal constants out of range** The programmed calibration constant is outside the acceptable range.
108	**Measurement cal constants out of range** The measurement calibration constant is outside the acceptable range.
109	**Over voltage cal constants out of range** The over voltage calibration constant is outside the acceptable range.
110	**Wrong V+I** The instrument was unable to set the correct voltage or current value.
111	**Aux vloc cal constants out of range** Calibration constants on the internal auxiliary local ADC are outside the acceptable range.
112	**Aux vrem cal constants out of range** Calibration constants on the internal auxiliary remote ADC are outside the acceptable range.
113	**Aux imon cal constants out of range** Calibration constants on the internal auxiliary imon ADC are outside the acceptable range.

	Device-dependent Errors (continued)
200	**Hardware error channel <channel>** A hardware error has occurred on the specified channel.
201	**Invalid configuration, empty slots** There is an empty slot between modules. This configuration is not allowed.
202	**Selftest Fail** A selftest failure has occurred. See selftest failure list for details.
203	**Compatibility function not implemented** The requested compatibility function is not available.
204	**NVRAM checksum error** A checksum error has occurred in the instrument's nonvolatile random access memory.
205	**NVRAM full** The nonvolatile random access memory of the instrument is full.
206	**File not found** The internal calibration file or the internal channel attribute file was not found in NVRAM.
207	**Cal file version error** The calibration file was written or read using old firmware. Firmware must be updated.
302	**Option not installed** The option that is programmed by this command is not installed.
303	**There is not a valid acquisition to fetch from** There is no valid data in the measurement buffer.
304	**Volt and curr in incompatible transient modes** Voltage and current cannot be in Step and List mode at the same time.
305	**A triggered value is on a different range** A triggered value is on a different range than the one that is presently set.
306	**Too many list points** Too many list points have been specified.
307	**List lengths are not equivalent** One or more lists are not the same length.
308	**This setting cannot be changed while transient trigger is initiated** Setting cannot be changed while the instrument is waiting for or executing a trigger sequence.
309	**Cannot initiate, voltage and current in fixed mode** Cannot initiate the transient generator because either the voltage or the current function is set to Fixed mode.

	Command Errors (these errors set Standard Event Status register bit #5)
–100	**Command error** Generic syntax error.
–101	**Invalid character** An invalid character was found in the command string.
–102	**Syntax error** Invalid syntax was found in the command string. Check for blank spaces.
–103	**Invalid separator** An invalid separator was found in the command string. Check for proper use of , ; :
–104	**Data type error** A different data type than the one allowed was found in the command string.
–105	**GET not allowed** A group execute trigger is not allowed in a command string.

	Command Errors (continued)
–108	**Parameter not allowed** More parameters were received than were expected.
–109	**Missing parameter** Fewer parameters were received than were expected.
–110	**Command header error** An error was detected in the header.
–111	**Header separator error** A character that was not a valid header separator was found in the command string.
–112	**Program mnemonic too long** The header contains more than 12 characters.
–113	**Undefined header** A command was received that was not valid for this instrument.
–114	**Header suffix out of range** The value of the numeric suffix is not valid.
–120	**Numeric data error** Generic numeric data error.
–121	**Invalid character in number** An invalid character for the data type was found in the command string.
–123	**Exponent too large** The magnitude of the exponent was larger than 32000.
–124	**Too many digits** The mantissa of a numeric parameter contained more than 255 digits, excluding leading zeros.
–128	**Numeric data not allowed** A numeric parameter was received but a character string was expected.
–130	**Suffix error** Generic suffix error
–131	**Invalid suffix** A suffix was incorrectly specified for a numeric parameter.
–134	**Suffix too long** The suffix contains more than 12 characters.
–138	**Suffix not allowed** A suffix is not supported for this command.
–140	**Character data error** Generic character data error
–141	**Invalid character data** Either the character data element contains an invalid character, or the element is not valid.
–144	**Character data too long** The character data element contains more than 12 characters.
–148	**Character data not allowed** A discrete parameter was received, but a string or numeric parameter was expected.
–150	**String data error** Generic string data error
–151	**Invalid string data** An invalid character string was received. Check that the string is enclosed in quotation marks.
–158	**String data not allowed** A character string was received, but is not allowed for this command.

	Command Errors (continued)
–160	**Block data error** Generic block data error
–161	**Invalid block data** The number of data bytes sent does not match the number of bytes specified in the header.
–168	**Block data not allowed** Data was sent in arbitrary block format but is not allowed for this command.
–170	**Expression error** Generic expression error
–171	**Invalid expression data** The expression data element was invalid.
–178	**Expression data not allowed** Expression data element was sent but is not allowed for this command.

	Execution Errors (these errors set Standard Event Status register bit #4)
–200	**Execution error** Generic syntax error
–220	**Parameter error** A data element related error occurred.
–221	**Settings conflict** A data element could not be executed because of the present instrument state.
–222	**Data out of range** A data element could not be executed because the value was outside the valid range.
–223	**Too much data** A data element was received that contains more data than the instrument can handle.
–224	**Illegal parameter value** An exact value was expected but not received.
–225	**Out of memory** The device has insufficient memory to perform the requested operation.
–226	**Lists not same length** One or more lists are not the same length.
–230	**Data corrupt or stale** Possible invalid data. A new reading was started but not completed.
–231	**Data questionable** The measurement accuracy is suspect.
–232	**Invalid format** The data format or structure is inappropriate.
–233	**Invalid version** The version of the data format is incorrect to the instrument.
–240	**Hardware error** The command could not be executed because of a hardware problem with the instrument.
–241	**Hardware missing** The command could not be executed because of missing hardware, such as an option.
–260	**Expression error** An expression program data element related error occurred.
–261	**Math error in expression** An expression program data element could not be executed due to a math error.

	Query Errors (these errors set Standard Event Status register bit #2)
–400	**Query Error** Generic error query
–410	**Query INTERRUPTED** A condition causing an interrupted query error occurred.
–420	**Query UNTERMINATED** A condition causing an unterminated query error occurred.
–430	**Query DEADLOCKED** A condition causing a deadlocked query error occurred.
–440	**Query UNTERMINATED after indefinite response** A query was received in the same program message after a query indicating an indefinite response was executed.

	Selftest Errors (these errors set Standard Event Status register bit #3)
202	**Selftest Fail Aux Adc 0 expected <n1> to <n2>, measured <n3>, chan <n4>** Auxiliary ADC failed. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 0 expected <n1> to <n2>, measured <n3>, chan <n4>** Both voltage and current DACs are at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 1 expected <n1> to <n2>, measured <n3>, chan <n4>** Voltage DAC is at zero; current DAC is at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 2 expected <n1> to <n2>, measured <n3>, chan <n4>** Voltage DAC is at full scale; current DAC is at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.
202	**Selftest Fail DACs 3 expected <n1> to <n2>, measured <n3>, chan <n4>** Both voltage and current DACs are at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

Appendix B
Backdating

Firmware Differences.....108

This appendix discusses differences in firmware revisions prior to revision D.01.07, D.00.00, and C.00.00.

Firmware Differences

Firmware Revisions Prior to D.01.07

The following features and capabilities are **not** available on mainframes with firmware revisions prior to D.01.07.

- Support for the N675xA/N676xA 300 W and 500 W power modules and the N6783A power modules.

Firmware Revisions Prior to D.00.00

The following features and capabilities are **not** available on mainframes with firmware revisions prior to D.00.00.

- Support for models N678xA SMU.

Firmware Revisions Prior to C.00.00

The following features and capabilities are **not** available on mainframes with firmware revisions prior to C.00.00.

- Support for the 300 W power modules.
- The power allocation function for power modules.
- The ability to reverse the polarity of the output and sense connectors.
- Compliance with LXI class C.

NOTE To upgrade your instrument with the latest firmware revision, go to http://www.agilent.com/find/N6700firmware.

Front Panel Menu Commands for Firmware Revisions prior to D.00.00

Menu Command					Control Description
Output	**Voltage**				Programs voltage setting and range.
	Current				Programs current setting and range.
	Delay				Programs Turn-on /Turn off delay.
	Slew				Programs voltage slew rate.
	Power				Programs the power allocation function.
	Pol				Lets you reverse the polarity of the output and sense terminals.
	Couple				Couples output channels for output on/off synchronization.
Measure	**Range**				Selects voltage and current measurement range.
	Sweep				Specifies measurement points, time interval, and trigger offset.
	Window				Selects measurement window: Rectangular, Hanning.
	Control				Lets you abort a measurement in progress.
Transient	**Mode**				Selects voltage or current transient mode: Fixed, Step, List.
	Step				Programs voltage and current step value. Enables step triggers.
	List	**Pace**			Specifies Dwell or Trigger paced list.
		Repeat			Specifies number of list repetitions, or specifies continuous list.
		Terminate			Specifies list settings when the list terminates.
		Config			Configures list step voltage, current, dwell, and trigger signals.
		Reset			Aborts the list and resets all list parameters.
	TrigSource				Specify the trigger source: Bus, Tran 1-4, Pin 1-7.
	Control				Initiates, Triggers, or Aborts output triggers. Displays trigger state.
Protect	**OVP**				Configures over-voltage protection function.
	OCP				Configures over-current protection function.
	Inhibit				Configures the external inhibit signal: Off, Latching, Live
	Coupling				Disables ALL output channels when a protection fault occurs.
	Clear				Clears output protection. Displays output state.
States	**Reset**				Resets the instrument to its reset (*RST) state.
	SaveRecall				Saves or recalls an instrument state.
	PowerOn				Selects the power-on state: *RST, RCL0.
System	**IO**	**LAN**	**ActiveSettings**		Displays the LAN interface settings that are presently active.
			Config	**IP**	Configures the IP addressing of the instrument.
				Name	Configures the Dynamic DNS and NetBIOS naming service.
				Domain	Configures the Domain Name.
				DNS	Configures the DNS server.
				TCP	Configures the TCP keepalive function.
				Reset	Resets the LAN interface settings to the factory-shipped state.
		USB	**Status**		Displays status, speed, packets received, and packets sent.
			Identification		USB connect string - the instrument's unique USB identifier.
		GPIB			Selects the GPIB address.

Menu Command					Control Description
System	**IO**	**DigPort**	**Pin1**	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut, FaultOut.
				Polarity	Specifies the pin polarity: Positive, Negative
			Pin2	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut.
				Polarity	Specifies the pin polarity: Positive, Negative
			Pin3	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut, InhibitIn.
				Polarity	Specifies the pin polarity: Positive, Negative
			Pin4	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut, OnC, OffC.
				Polarity	Specifies the pin polarity: Positive, Negative
			Pin5	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut, OnC, OffC.
				Polarity	Specifies the pin polarity: Positive, Negative
			Pin6	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut, OnC, OffC.
				Polarity	Specifies the pin polarity: Positive, Negative
			Pin7	**Function**	Specifies the pin function: DigIn, DigIO, TrigIn, TrigOut, OnC, OffC.
				Polarity	Specifies the pin polarity: Positive, Negative
			Data		Sends/reads data from the digital I/O port
	Groups				Defines groups of output channels that are connected in parallel.
	Preferences	**Display**	**Contrast**		Configures the display contrast.
			Saver		Configures the screen saver and wake-on I/O timer.
			View		Selects 1-channel or 4-channel view at turn-on
		Keys			Enables/disables key clicks and configures the On/Off key.
		Lock			Locks front panel keys. Enter a password to unlock the front panel.
	Admin	**Login/Logout**			Enter a password to access the admin functions.
		Cal	**Function**	**Vprog**	**High** Enters measured data for the High calibration point. **Low** Enters measured data for the Low calibration point.
				Vmeas	Enters measured data.
				CMRR	Calibrates common mode rejection ratio.
				Iprog	**High** Enters measured data for the High calibration point. **Low** Enters measured data for the Low calibration point.
				Imeas	**100mA** Enters measured data for the 100 mA range point. **200uA** Enters measured data for the 200 μA range point.
				Dprog	Calibrates the downprogrammer.
				Ipeak	Calibrates I peak.
			Date		Saves the calibration date for each channel.
			Save		Saves the calibration data.
		LAN			Enables/disables the LAN interface and the built-in Web server.
		USB			Enables/disables the USB interface.
		Nvram			Resets all non-volatile RAM settings to their factory defaults.
		Password			Changes the password for the admin functions.
	About	**Frame**			Displays model, serial number, and firmware revisions.
		Module			Displays model, serial number, options, voltage, current, power.

Front Panel Menu Commands for Firmware Revisions prior to C.00.00

Menu Command				Control Description
Output	**Voltage**			Programs voltage setting and range.
	Current			Programs current setting and range.
	Delay			Program Turn-on /Turn Off delay.
Measure	**Range**			Selects voltage and current measurement range.
	Sweep			Specifies measurement points, time interval, and trigger offset.
	Window			Selects measurement window (Rectangular/Hanning).
	Control			Lets you abort a measurement in progress.
Transient	**Mode**	**Voltage**		Selects voltage mode (Fixed, Step, or List).
		Current		Selects current mode (Fixed, Step, or List).
	Step			Programs voltage and current steps. Enables step trigger signals.
	List	**Pace**		Specifies Dwell or Trigger paced list.
		Repeat		Specifies number of list repetitions, or specifies continuous list.
		Terminate		Specifies list settings when the list terminates.
		Config		Configures the list steps. Specify voltage, current, and dwell values. Also specifies trigger output signal states.
		Reset		Aborts the list and resets all list parameters.
	TrigSource			Specify the trigger source: bus, tran 1-4, pin 1-3.
	Control			Initiate, Trigger, or Abort output triggers.
Protect	**OVP**			Configures over-voltage protections function.
	OCP			Configures over-current protections function.
	Inhibit			Configures the external inhibit signal.
	Coupling			Disables ALL output channels when a protection fault occurs.
	Clear			Clears output protection.
States	**Reset**			Resets the instrument to its reset (*RST) state.
	Save/Recall			Saves or recalls an instrument state.
	PowerOn			Selects the power on state.
System	**Interface**	**LAN**	**Status**	Displays interface status information.
			IP	Enables/disables DHCP and Auto IP. Also sets the IP Address, Subnet Mask, and Default Gateway.
			DNS	Configures the DNS server.
			Name	Configures the Dynamic DNS and NetBIOS naming service.
			Domain	Configures the Domain Name.
			TCP	Configures the TCP keepalive function.
			Enable	Enables/disables the LAN interface and the built-in Web server.
		USB	**Status**	Displays status, speed, packets received, and packets sent.
			Identification	USB connect string - the instrument's unique USB identifier
			Enable	Enables/disables the USB interface.
		GPIB		Selects the GPIB address.
		Reset		Resets the interface settings to the factory-shipped state.

Menu Command				Control Description
System	**DigPort**	**Pin 1**	**Function**	Specifies the pin function: DigIO, TrigIn, TrigOut, DigIn, or FaultOut..
			Polarity	Specifies the pin polarity.
		Pin 2	**Function**	Specifies the pin function: DigIO, TrigIn, TrigOut, or DigIn.
			Polarity	Specifies the pin polarity.
		Pin 3	**Function**	Specifies the pin function: DigIO, TrigIn, TrigOut, DigIn, or InhibitIn.
			Polarity	Specifies the pin polarity.
		Data		Sends/reads data from the digital I/O port function
	Preferences	**Display**		Configures Screen saver, Wake-on I/O, and Display contrast.
		Keys		Enables/disables key clicks and configures the On/Off key.
		Security	**ResetNVRam**	Resets all non-volatile RAM settings to their factory defaults.
	Error			Displays the Error log.
	Calibrate	**State**		Enables/disables calibration. You must supply a password to enable.
		Sequence	**VProg**	**High** Enters measured data for high calibration point.
				Low Enters measured data for low calibration point.
			VMeas	Enters measured data.
			CMRR	Calibrates common mode rejection ratio.
			IProg	**High** Enters measured data for high calibration point.
				Low Enters measured data for low calibration point.
			IMeas	Enters Measured data.
			DPRog	Calibrates the downprogrammer.
			IPeak	Calibrates I peak.
		Date		Saves the calibration date for each channel.
		Save		Saves the calibration data.
		Password		Changes the password.
	About	**Frame**		Displays model, serial number, firmware revision, backup revision, and active firmware.
		Module		Displays model, serial number, options, voltage, current, and power.

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